MYCOLOGIA

OFFICIAL ORGAN OF THE MYCOLOGICAL SOCIETY OF AMERICA

Vol. XLI JANUARY-FEBRUARY, 1949 No. 1

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PUBLISHED BIMONTHLY FOR
THE NEW YORK BOTANICAL GARDEN
AT PRINCE AND LEMON STS., LANCASTER, PA.

Entered as second-class matter April 30, 1925, at the post office at Lancaster, Pa., under the Act of August 24, 1912.

MYCOLOGIA

Published by

THE NEW YORK BOTANICAL GARDEN

IN COLLABORATION WITH THE

MYCOLOGICAL SOCIETY OF AMERICA

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MYCOLOGIA

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OBSERVATIONS ON STREPTOMYCES GRISEUS. III. CARBON SOURCES FOR GROWTH AND STREPTOMYCIN PRODUCTION [1]

EUGENE L. DULANEY

In a previous paper (**1**), the use of various compounds as nitrogen sources for growth and streptomycin production in a synthetic medium was discussed. Glucose always served as the carbohydrate in these experiments.

Thus far, little has been disclosed of the use of various carbohydrates in streptomycin fermentation mediums. The meat extract-peptone medium of Schatz, Bugie, and Waksman (**5**), the soy bean medium of Rake and Donovick (**3**), and the near synthetic medium of Vander Brook *et al.* (**6**) all contained glucose. Hubbard and Thornberry (**2**), using surface fermentations, tested a number of carbon sources. These compounds, both sugars and alcohols, were added to a basal medium containing ammonium lactate and mineral salts. Of the compounds tested, d-mannose, d-galactose, maltose, cellobiose, mannitol, and dextrin supported the highest yields. Saunders and Sylvester (**4**) also tested a few sugars and organic acids as constituents of a synthetic streptomycin fermentation medium. They employed submerged fermentations with a basal medium containing a sugar, an organic acid, an inorganic nitrogen compound, and mineral salts. Five sugars, namely, glucose, dextrin, brown sugar, starch, and lactose, were

[1] Contribution from the Research Laboratories of Merck & Co., Inc.

[MYCOLOGIA for November–December (**40**: 639–790) was issued December 23, 1948]

tested. Glucose, dextrin, and starch supported the highest yields. Of the organic acids tested, lactic and acetic gave the best results.

This paper concerns the possible substitution of a number of carbon sources, *i.e.*, sugars, alcohols, and organic acids, for glucose in synthetic streptomycin fermentation mediums.

MATERIALS AND METHODS

The experimental conditions were the same as those employed in the testing of various nitrogen sources in synthetic streptomycin fermentation mediums (**1**).

Cultures were developed by spreading spores from the soil tube previously used (**1**) over Blake bottle slants of yeast extract-glucose agar. After seven days' incubation at 28° C., fifty ml. of sterile distilled water were added to each Blake bottle culture and a spore suspension prepared. One ml. of this spore suspension was added to each fermentation flask.

The basal medium contained the following salts in one liter of distilled water: NaCl 5.0 gm., K_2HPO_4 2.0 gm., $MgSO_4 \cdot 7H_2O$ 1.0 gm., $CaCl_2$ 0.4 gm., $FeSO_4 \cdot 7H_2O$ 20.0 mg., and $ZnSO_4 \cdot 7H_2O$ 10.0 mg. The nitrogen and carbon sources were added to this salt solution. Because the metabolism of the carbohydrate is affected by the nitrogen source, each carbon source was tested in mediums containing three different nitrogen sources. These nitrogen compounds were employed at the following concentrations: $(NH_4)_2HPO_4$ at 4.0 gm. per liter, enzyme-digested casein at 10.0 gm. per liter, and l(−)proline at 15 gm. per liter. The carbon sources were added to these three different mediums before sterilization and the pH adjusted, when necessary, to between 7.0 and 7.5 with 1 N NaOH.

The mediums were dispensed in 40-ml. amounts in 125-ml. Erlenmeyer flasks and autoclaved at 121° C. for 17 minutes. The pH was checked after autoclaving, and no medium with an initial pH below 6.5 was used. After inoculation, the flasks were incubated at 28° C. on a rotary-type shaker moving at 220 r.p.m. so that it described a circle one inch in diameter. After growth started, the flasks were sampled daily until after the maximum broth potencies were reached. The whole broth samples

were assayed daily by the agar plate method using streptomycin calcium chloride complex as a standard.

EXPERIMENTAL RESULTS

The carbon sources that were tested included sugars, alcohols, and organic acids. All of these compounds were added to the mediums at a 1.0 per cent level.

The streptomycin broth potencies produced in the mediums with various sugars serving as the carbon source are shown in table I. When alcohols were substituted for the sugars, the re-

TABLE I

SUGARS AS CARBON SOURCES

Sugar	Nitrogen Source	Maximum Streptomycin Broth Potency—γ/ml.	Day of Maximum
d-arabinose	$(NH_4)_2HPO_4$	very slight growth	
d-arabinose	casein digest	76	3
d-arabinose	l(−)proline	11	12
l-arabinose	$(NH_4)_2HPO_4$	very slight growth	
l-arabinose	casein digest	121	3
l-arabinose	l(−)proline	very slight growth	
fucose	$(NH_4)_2HPO_4$	no growth	
fucose	casein digest	99	3
fucose	l(−)proline	33	11
lyxose	$(NH_4)_2HPO_4$	poor growth	
lyxose	casein digest	150	3
lyxose	l(−)proline	very slight growth	
l-rhamnose	$(NH_4)_2HPO_4$	very slight growth	
l-rhamnose	casein digest	220	5
l-rhamnose	l(−)proline	13	9
d-ribose	$(NH_4)_2HPO_4$	10	8
d-ribose	casein digest	236	5
d-ribose	l(−)proline	very slight growth	
d-xylose	$(NH_4)_2HPO_4$	no growth	
d-xylose	casein digest	171	3
d-xylose	l(−)proline	no growth	
l-xylose	$(NH_4)_2HPO_4$	48	14
l-xylose	casein digest	183	3
l-xylose	l(−)proline	79	10
glucose	$(NH_4)_2HPO_4$	136	6
glucose	casein digest	439	4
glucose	l(−)proline	800	12
galactose	$(NH_4)_2HPO_4$	123	5
galactose	casein digest	369	4
galactose	l(−)proline	124	12
levulose	$(NH_4)_2HPO_4$	116	9
levulose	casein digest	260	4
levulose	l(−)proline	525	10
d(+)mannose	$(NH_4)_2HPO_4$	85	7
d(+)mannose	casein digest	221	3
d(+)mannose	l(−)proline	900	10

TABLE I—*Continued*

Sugar	Nitrogen Source	Maximum Streptomycin Broth Potency—γ/ml.	Day of Maximum
l-sorbose	$(NH_4)_2HPO_4$	very slight growth	
l-sorbose	casein digest	41	5
l-sorbose	l(−)proline	no growth	
cellobiose	$(NH_4)_2HPO_4$	54	5
cellobiose	casein digest	244	4
cellobiose	l(−)proline	347	10
lactose	$(NH_4)_2HPO_4$	108	5
lactose	casein digest	247	4
lactose	l(−)proline	588	11
maltose	$(NH_4)_2HPO_4$	140	8
maltose	casein digest	269	4
maltose	l(−)proline	800	11
melibiose	$(NH_4)_2HPO_4$	no growth	
melibiose	casein digest	146	4
melibiose	l(−)proline	272	9
sucrose	$(NH_4)_2HPO_4$	poor growth	
sucrose	casein digest	80	4
sucrose	l(−)proline	134	10
melezitose	$(NH_4)_2HPO_4$	very slight growth	
melezitose	casein digest	146	4
melezitose	l(−)proline	108	8
raffinose	$(NH_4)_2HPO_4$	very slight growth	
raffinose	casein digest	51	6
raffinose	l(−)proline	48	12
dextrin	$(NH_4)_2HPO_4$	74	7
dextrin	casein digest	235	4
dextrin	l(−)proline	630	8
inulin	$(NH_4)_2HPO_4$	no growth	
inulin	casein digest	112	3
inulin	l(−)proline	69	11
starch	$(NH_4)_2HPO_4$	103	8
starch	casein digest	293	4
starch	l(−)proline	433	8
no sugar	casein digest	93	3
no sugar	l(−)proline	43	12

sults shown in table II were obtained. Of the fifteen organic acids that are listed in table III, only seven supported growth and streptomycin production. The results given in table III were obtained in the $(NH_4)_2HPO_4$ medium to which the organic acids were added.

It will be noted that in some instances growth is recorded as very slight. In appraising these results, one should remember that the inoculum was grown on yeast extract-glucose agar. Spores from such cultures were not washed before being added to the mediums. Perhaps enough organic material was transferred with the inoculum to allow slight growth.

TABLE II

ALCOHOLS AS CARBON SOURCES

Alcohol	Nitrogen Source	Maximum Streptomycin Broth Potency—γ/ml.	Day of Maximum
methanol	$(NH_4)_2HPO_4$	no growth	
methanol	casein digest	51	4
methanol	l(−)proline	2	10
ethanol	$(NH_4)_2HPO_4$	no growth	
ethanol	casein digest	75	3
ethanol	l(−)proline	2	10
propanol	$(NH_4)_2HPO_4$	no growth	
propanol	casein digest	53	4
propanol	l(−)proline	0	
butanol	$(NH_4)_2HPO_4$	no growth	
butanol	casein digest	55	3
butanol	l(−)proline	7	11
glycerol	$(NH_4)_2HPO_2$	82	11
glycerol	casein digest	156	4
glycerol	l(−)proline	176	10
erythritol	$(NH_4)_2HPO_4$	no growth	
erythritol	casein digest	22	4
erythritol	l(−)proline	11	10
pentaerythritol	$(NH_4)_2HPO_4$	no growth	
pentaerythritol	casein digest	38	4
pentaerythritol	l(−)proline	7	11
sorbitol	$(NH_4)_2HPO_4$	no growth	
sorbitol	casein digest	0	
sorbitol	l(−)proline	0	
dulcitol	$(NH_4)_2HPO_4$	no growth	
dulcitol	casein digest	37	5
dulcitol	l(−)proline	17	9
mannitol	$(NH_4)_2HPO_4$	162	10
mannitol	casein digest	242	4
mannitol	l(−)proline	700	10
inositol	$(NH_4)_2HPO_4$	no growth	
inositol	casein digest	60	3
inositol	l(−)proline	42	11
no alcohol	casein digest	93	3
no alcohol	l(−)proline	43	12

DISCUSSION

Sugars: None of the pentoses supported high yields of streptomycin. Only two aldopentoses, namely, d-ribose and l-xylose, supported streptomycin production in the medium containing an inorganic nitrogen source. The yields thus obtained were quite low, 10 γ/ml. and 48 γ/ml., respectively. Neither of the methylpentoses, namely, l-rhamnose or fucose, supported yields in the $(NH_4)_2HPO_4$ medium. In the medium containing enzyme-digested casein as the nitrogen source, the use of l-arabinose, lyxose, l-rhamnose, d-ribose, d-xylose, and l-xylose resulted in

TABLE III

ORGANIC ACIDS AS CARBON SOURCES

Organic Acid	Nitrogen Source	Maximum Streptomycin Broth Potency—γ/ml.	Day of Maximum
adipic	$(NH_4)_2HPO_4$	no growth	
acetic	$(NH_4)_2HPO_4$	no growth	
citric	$(NH_4)_2HPO_4$	9	8
fumaric	$(NH_4)_2HPO_4$	5	5
gallic	$(NH_4)_2HPO_4$	no growth	
gluconic	$(NH_4)_2HPO_4$	9	7
lactic	$(NH_4)_2HPO_4$	13	8
levulinic	$(NH_4)_2HPO_4$	no growth	
malic	$(NH_4)_2HPO_4$	8	5
malonic	$(NH_4)_2HPO_4$	no growth	
oxalic	$(NH_4)_2HPO_4$	no growth	
pimelic	$(NH_4)_2HPO_4$	no growth	
pyruvic	$(NH_4)_2HPO_4$	22	9
succinic	$(NH_4)_2HPO_4$	2	8
tartaric	$(NH_4)_2HPO_4$	no growth	

streptomycin titers significantly higher than were obtained in the casein medium with no sugar added. Perhaps some of the pentoses would support high yields if some specific amino acids served as the nitrogen source. With l(−)proline as the nitrogen source, however, none of the pentoses except l-xylose resulted in yields higher than were obtained in the proline medium to which no sugar had been added.

All three of the aldohexoses, *i.e.*, glucose, d(+)mannose and galactose, supported growth and streptomycin production though the yields were markedly different depending upon the nitrogen source used in the medium. In the $(NH_4)_2HPO_4$ and casein-digest mediums, glucose was the best of the three sugars, with galactose intermediate and d(+)mannose supporting the lowest yields. However, in the medium containing l(−)proline as the sole nitrogen source, the use of d(+)mannose resulted in exceptionally high streptomycin broth potencies. High yields were also obtained with glucose in combination with l(−)proline but not with galactose plus l(−)proline.

Two ketohexoses were tested. Sorbose would not support growth in the $(NH_4)_2HPO_4$ medium. In addition, when sorbose was added to the casein-digest medium, lower yields were obtained than in the casein-digest medium to which no sugar had been added. Also, no growth was obtained in the l(−)proline me-

dium to which sorbose was added. Levulose, on the other hand, was a relatively good carbohydrate, though not so satisfactory as glucose.

In all, five disaccharides were tested. All of the C_4-disaccharides, *i.e.*, cellobiose, lactose, and maltose, supported growth and streptomycin production in the $(NH_4)_2HPO_4$ medium. Of these three, maltose was superior when used in conjunction with an inorganic nitrogen source. In the casein-digest medium, however, approximately comparable yields were obtained with all three. When l(−)proline served as the sole nitrogen source, the use of maltose resulted in yields far superior to those obtained through the use of lactose or cellobiose.

Melibiose, a C_6-disaccharide, supported the best yields when used in the medium with l(−)proline. When used with the inorganic nitrogen compound, no growth was obtained.

Sucrose, a disaccharide with the hexose molecules linked through the reducing groups, was a poor carbon source in the $(NH_4)_2HPO_4$ medium. In addition, sucrose was also an inferior carbohydrate in the casein-digest and l(−)proline mediums.

The two trisaccharides, namely, melezitose and raffinose, do not offer much promise. Growth was not obtained when they were used in the $(NH_4)_2HPO_4$ medium, and low broth potencies were produced when they were used in conjunction with the organic nitrogen sources.

Of the polysaccharides, only inulin failed to support growth when used with an inorganic nitrogen compound. In addition, low streptomycin broth potencies were obtained in the inulin-casein digest and inulin-l(−)proline mediums. Dextrin and starch, however, appear to be promising carbohydrates, though neither of the lots tested was as good as glucose in the casein-digest or $(NH_4)_2HPO_4$ mediums. Both dextrin and starch supported relatively high yields in the l(−)proline mediums. The results would seem to warrant the testing of a series of dextrins and starches.

Alcohols: In all, eleven alcohols were tested in the three mediums. Of these eleven, only glycerol and mannitol supported growth in the $(NH_4)_2HPO_4$ medium. The use of glycerol resulted in relatively low streptomycin broth potencies in all three

mediums. Mannitol, however, when used in the $(NH_4)_2HPO_4$ or l(−)proline mediums, supported yields about equal to those obtained with the use of glucose in these mediums.

The addition of the other alcohols to the casein digest or l(−)proline mediums resulted in lower yields than were obtained in these two mediums to which no alcohol was added. Sorbitol exerted the most deleterious effect. No streptomycin was formed in the casein digest of l(−)proline mediums to which sorbitol was added.

Organic Acids: The fifteen organic acids listed in table III were tested in the $(NH_4)_2HPO_4$ and casein-digest mediums. The l(−)proline medium was not used.

When the organic acids were added to the casein-digest medium, the resulting streptomycin broth potencies were always lower than those obtained in the casein-digest medium to which no organic acid was added. Only seven of these acids supported growth and streptomycin formation in the medium with inorganic nitrogen. The highest broth potency obtained was 22 γ/ml. in the pyruvic acid $(NH_4)_2HPO_4$ medium.

The results with organic acids indicate that they offer little promise when used singly in place of carbohydrates in synthetic streptomycin fermentation mediums.

It is obvious from the above results that quite high streptomycin broth potencies may be obtained in synthetic mediums. Moreover, the specific carbon source added to these mediums greatly affects the fermentation.

Among the sugars, the pentoses and trisaccharides do not offer much promise when used as single carbohydrates. A number of the hexoses, disaccharides, and polysaccharides supported quite high streptomycin titers. There seems to be no clear correlation between the structure of the sugar molecule and the yield obtained. A number of these more promising sugars, however, are composed of glucose molecules.

With the exception of mannitol, none of the alcohols supported high yields. The organic acids that were tested were likewise poor carbon sources.

In analyzing the above results, however, several points should be borne in mind. The compounds tested were added singly to

the three mediums. With an increasing knowledge of the mechanism operating in the streptomycin fermentation, various combinations of these compounds might be used to advantage. In addition, these compounds were tested with one set of fermentation conditions using only three different nitrogen sources. The nitrogen source has a striking effect on the availability of the carbohydrate. The results obtained in the $(NH_4)_2HPO_4$ and l(−)proline mediums to which d(+)mannose was added serve as examples. Low streptomycin broth potencies were obtained in the mannose-$(NH_4)_2HPO_4$ medium, whereas good growth and high streptomycin broth potencies were obtained in the mannose-proline medium. In an attempt to stimulate streptomycin production in the mannose-$(NH_4)_2HPO_4$ medium, a number of organic acids, *i.e.*, acetic, citric, lactic, fumaric, pyruvic, succinic, and malic, were added as individual supplements at a 0.05 per cent level to this medium. In no instance did a stimulation of streptomycin production occur. Several amino acids, *i.e.*, dl-alpha-alanine, l-aspartic acid, l(−)proline, l(−) leucine, l-glutamic acid, and glycine, were also used as individual supplements to this medium. Again there was no stimulation of streptomycin production.

It should also be noted that the criterion used in these experiments was streptomycin broth potency and not growth. It does not necessarily follow that good growth will result in high streptomycin titers.

SUMMARY

1. A number of sugars, alcohols, and organic acids were tested as carbon sources in three streptomycin fermentation mediums.

2. The streptomycin broth potency obtained was greatly affected by the carbon source as well as by the source of nitrogen employed in the medium. The highest yields were obtained in the medium with l(−)proline as the sole nitrogen source.

3. The pentoses were poor carbon sources.

4. Among the hexoses, glucose and mannose supported the highest yields. The high streptomycin titers obtained by the use of mannose occurred only in the medium containing l(−)proline as the nitrogen source.

5. Maltose was the best of the disaccharides.

6. The trisaccharides were inferior carbohydrates under the experimental conditions that were used.

7. The only polysaccharide supporting low yields was inulin. The results obtained with the starch and dextrin would appear to warrant the testing of a series of these compounds.

8. Among the alcohols, only mannitol was a promising carbon source.

9. None of the organic acids supported high streptomycin broth potencies.

LITERATURE CITED

1. **Dulaney, Eugene L.** 1948. Observations on *Streptomyces griseus*. II. Nitrogen sources for growth and streptomycin production. Jour. Bact. **56**: 305–313.
2. **Hubbard, C. V., and H. H. Thornberry.** 1946. Utilization of various carbohydrates by *Streptomyces griseus* for production of streptomycin and growth. Trans. Ill. Acad. Sci. **39**: 57–64.
3. **Rake, Geoffrey, and Richard Donovick.** 1946. Studies on the nutritional requirements of *Streptomyces griseus* for the formation of streptomycin. Jour. Bact. **52**: 223–228.
4. **Saunders, Allen, and J. C. Sylvester.** 1947. Synthetic media for the production of streptomycin. Paper presented before the Amer. Chem. Soc., Sept., 1947.
5. **Schatz, A., E. Bugie, and S. A. Waksman.** 1944. Streptomycin, a substance exhibiting antibiotic activity against gram positive and gram negative bacteria. Proc. Soc. Exp. Biol. Med. **55**: 66–69.
6. **Vander Brook, Milton J., Arne N. Wick, William H. DeVries, Roberta Harris, and George F. Cartland.** 1946. Extraction and purification of streptomycin with a note on streptothricin. Jour. Biol. Chem. **165**: 463–468.

THE ALBERT COMMONS * COLLECTION OF FUNGI IN THE HERBARIUM OF THE ACADEMY OF NATURAL SCIENCES IN PHILADELPHIA

DAVID R. SUMSTINE

This collection of fungi has been stored in the Academy of Natural Sciences for many years. The specimens are still in the original containers, such as newspapers, small match boxes, and other boxes, and identifications as well as other data are written on the blank parts of the newspaper and on the boxes. Some collections have a printed label. With the exception of the agarics, the specimens are well preserved for the most part and the material is generally ample. The specimens of agarics were pressed and only a few have been identified. There are no field notes giving the color, texture and other desirable characters for identification.

Most of the material was evidently identified by J. B. Ellis in whose herbarium duplicates of most of these specimens probably will be found. But many specimens were also sent to Charles H. Peck, A. B. Seymour, and William Trelease for identification. The name of the person identifying the specimen is generally given, and many are marked as new species. The original description usually refers definitely to the collection number and locality given on the label of the specimen. From this it would appear that these specimens are types or isotypes. Most of the specimens were collected in Delaware but a few came from New Jersey, Maryland, and Pennsylvania.

This collection has intrigued me for many years as I made frequent visits to the Academy of Natural Sciences. Some time ago,

* Albert Commons was born in Doe Run, Chester County, Pennsylvania, January 23, 1829. He became interested in Botany through his half-brother Franklin Commons. He began collecting in Delaware in 1842. His collections consist of flowering plants, mosses, hepatics, lichens and fungi. He died in 1919.

I suggested to Dr. F. W. Pennell, Curator of Plants, that the collection should be made available to mycologists for study, and offered to undertake its arrangement if the Academy would provide the necessary supplies. My offer was readily accepted and the specimens have been placed in suitable packets with printed labels.

No attempt has been made to make a critical study of these more than 4,000 specimens. The purpose is only to arrange them and make them accessible for study. Mycologists will find here a rich field for investigation.

In presenting a list of the species in one group, the Hyphomycetes, I hope to give a general idea of this collection. This enumeration will include the name of the species as given by the person identifying it, the collection number, the host, the locality, and the date.

A few personal notes will give some information that seemed valuable. When a specimen is marked as a new species, the original publication is given. This means that the publication refers directly to that specimen. Some of these specific names are, no doubt, synonyms and some should be transferred to other genera. This transfer will be left for specialists in the various groups. Probably at some future date, an enumeration of the other groups will be published.

All correspondence concerning permission to examine these specimens should be addressed to Dr. F. W. Pennell, Academy of Natural Sciences, Philadelphia, Pa.

HYPHOMYCETES

FAMILY MUCEDINACEAE. 1. *Botrytis fulva* Lk., (*1472*), on the ground; Wilmington, June 18, 1890. 2. *Botrytis geniculata* Cda., (*2026*), on *Carya;* Naaman's Creek, Nov. 14, 1892. 3. *Botrytis geniculata* Cda., (*2278*), on *Hypoxylon;* Wilmington, Sept. 29, 1893. 4. *Botrytis geniculata* Cda., (*2221*), on *Hypoxylon;* Wilmington, Aug. 18, 1893. 5. *Botrytis streptothrix* (C. & E.) Sacc., (*2216*), (*Polyactis streptothrix* C. & E.), on *Orontium aquaticum;* Newark, Sept. 1, 1893. 6. *Botrytis streptothrix* (C. & E.) Sacc., (*1429*), on *Symplocarpus foetidus;* Wilmington,

May 18, 1890. 7. *Botrytis streptothrix* (C. & E.) Sacc., (*1484*), on *Hydrastis canadensis;* Wilmington, July 10, 1890. 8. *Botrytis streptothrix* (C. & E.) Sacc., (*2081*), on *Hydrastis canadensis;* Wilmington, June 29, 1893. 9. *Botrytis streptothrix* (C. & E.) Sacc., (*2487*), on *Arisaema triphyllum;* Naaman's Creek, July 6, 1894. 10. *Botrytis vulgaris* Fr., (*1792*), on *Staphylea trifolia;* Wilmington, July 7, 1891. 11. *Oidium megalosporum* B. & C., (*2003*), on decayed wood; Wilmington, Oct. 29, 1892. 12. *Oidium simile* Berk., (*2745*), (*Monilia aurea-fulva*), on decayed wood; Wilmington, Oct. 15, 1890. 13. *Oidium simile* Berk., (*1835*), on decayed wood; Wilmington, Oct. 1, 1891. 14. *Oidium simile* Berk., (*2288*), on decayed wood; Wilmington, Aug. 18, 1890. 15. *Oidium simile* Berk., (*1998*), on decayed wood; Ogden Station, Sept. 15, 1892. 16. *Piricularia grisea* (Cke.) Sacc., (*120*), (*Tricothecium griseum* Cke.), on *Panicum sanguinale;* Faulkland, Aug. 21, 1885. Note: See number 42. 17. *Piricularia grisea* (Cke.) Sacc., (*1539*), var. *parasitica* E. & E. nov. var, in ed., on *Phyllachora graminis;* Wilmington, Aug. 18, 1890. 18. *Polyscytalum sericeum* Sacc., (*552*), on oak leaves; Faulkland, July 22, 1887.

19. *Ramularia andromedae* E. & M., (*1431*), on *Andromeda ligustrina;* Wilmington, May 29, 1890. 20. *Ramularia andromedae* E. & M., (*1481*), on *Andromeda ligustrina;* Wilmington, June 19, 1899. 21. *Ramularia arvensis* Sacc., (*71*), on *Potentilla canadensis;* Faulkland, Sept. 12, 1885. 22. *Ramularia arvensis* Sacc., (*49*), No data. 23. *Ramularia barbareae* Pk., (*1184*), on *Barbarea vulgaris;* Wilmington, Dec. 19, 1889. 24. *Ramularia celastri* E. & M., (*613*), on *Celastrus scandens;* Faulkland, Aug. 10, 1887. 25. *Ramularia heraclei* (Oud.) Sacc., (*1616*), on *Heracleum lanatum;* Wilmington, Sept. 24, 1890. 26. *Ramularia macrospora* Fres., (= *216*), on *Rumex obtusifolia;* Naaman's Creek, July 10, 1893. Note: This has been identified also as *R. decipiens* E. & E. and *R. obovata* (Fckl.) Sacc. 27. *Ramularia orontii* E. & M., (*2215*), on *Orontium aquaticum;* Newark, Sept. 8, 1893. 28. *Ramularia plantaginis* E. & M., (*2186*), on *Plantago major;* Wilmington, Aug. 7, 1893. 29. *Ramularia pratensis* Sacc., (*216*), on *Rumex obtusifolia;* Faulkland, Aug. 25, 1885. 30. *Ramularia pratensis* Sacc., (= *216*), on *Rumex crispus;* Wilming-

ton, May 22, 1890. Note: The species on *Rumex crispus* seems to be generally labeled as *R. decipiens* E. & E., 31. *Ramularia pratensis* Sacc., (*612*), on Rhubarb; Delaware City, Aug. 12, 1887. 32. *Ramularia pratensis* Sacc., (= *216*), on *Rumex* sp.; Wilmington, Nov. 6, 1893. 33. *Ramularia ranunculi* Pk., (*1418*), on *Ranunculus* sp.; Newark, May 21, 1890. 34. *Ramularia Tulasnei* Sacc., (*50*), on *Fragaria virginiana;* Wilmington, Oct. 17, 1889. 35. *Rhinotrichum Curtisii* Berk., (*1581*), on decayed wood; Wilmington, July 21, 1890. 36. *Rhinotrichum Curtisii* Berk., (*2279*), on decayed wood; Wilmington, Sept. 28, 1893. 37. *Rhinotrichum ramosissimum* B. & C., (*1636*), on decayed wood; Sept. 30, 1890. 38. *Rhinotrichum ramosissimum* B. & C., (*1490*) and (*581*), on decayed wood; Wilmington, July 7, 1890. 39. *Sepedonium chrysospermum* (Bull.) Fr., on agaric; Mt. Cuba, July 19, 1894. 40. *Sporotrichum Bombacinum* Lk., (*1080*), on pine boards; Wilmington, Oct. 22, 1889. 41. *Trichoderma lignorum* (Tode) Harz., (*2194*), on *Polyporus;* Wilmington, Sept. 11, 1893. 42. *Trichothecium griseum* Cke., (*120*), on *Panicum sanguinale;* Faulkland, Aug. 21, 1885. Note: See number 16. 43. *Trichothecium roseum* (Pers.) Lk., (*2103*) and (*667*), on *Platanus occidentalis;* Naaman's Creek, July 10, 1893.

FAMILY DEMATIACEAE. 1. *Alternaria brassicae* Berk., (*94*), on cabbage; Faulkland, Oct. 12, 1885. 2. *Cercospora acalyphae* Pk., (*170*), on *Acalypha virginica;* Faulkland, Sept. 12, 1885. 3. *Cercospora acnidae* E. & E. n. sp., (*1011*), on *Acnida cannabia;* Wilmington, Sept. 1, 1889; Sept. 30, 1890, Proc. Acad. Phil. **43**: 89, 1891. Note: See also specimen *2582* in N.A.F. 4. *Cercospora ageratoides* E. & E., (*1842*), on *Eupatorium ageratoides;* Wilmington, Oct. 9, 1891. 5. *Cercospora ageratoides* E. & E., (*2599*), on *Eupatorium ageratoides;* Wilmington, Oct. 22, 1894. 6. *Cercospora althaeina* Sacc., (*103*), on *Abutilon avicennae;* Faulkland, Sept. 19, 1895. 7. *Cercospora althaeina* Sacc., (*183*), on *Malva rotundifolia;* Faulkland, Oct. 2, 1885. 8. *Cercospora ampelopsidis* Pk., (*51*), on *Ampelopsis quinquefolia;* Faulkland, July 10, 1885. 9. *Cercospora ampelopsidis* Pk., (*58*), on *Tecoma radicans;* Faulkland, Sept. 12, 1885. 10. *Cercospora asclepiadis* Ellis, (*846*), on *Accrates viridiflora;* Centerville, Aug. 11, 1875. Note: Near *Cercospora venturioides* Pk. 11. *Cercospora as-*

clepiadis Ellis, (*2468*), on *Asclepias cornuti;* Stanton, July 4, 1894. 12. *Cercospora atra* E. & E. n. sp., (*591*), on *Diospyrus virginiana;* Faulkland, Aug. 8, 1887, Jour. Myc. **4**: 4. 1888. 13. *Cercospora avicularis* Wint., on *Polygonum aviculare;* Faulkland, Aug. 1886. 14. *Cercospora bochmeriae* Pk., (*2214*), on *Bochmeria cylindrica;* Wilmington, Sept. 5, 1893. 15. *Cercospora brachiata* E. & E. n. sp., (*626*), on *Amaranthus retroflexus;* Faulkland, Aug. 18, 1887, Jour. Myc. **4**: 5. 1888. 16. *Cercospora brachiata* E. & E., (*2600*), on *Amaranthus blitoides;* Wilmington, Oct. 22, 1894. 17. *Cercospora briareus* E. & E. n. sp., (*2537*), on *Acerates viridifolia;* Elkton, Maryland, Aug. 21, 1894, Proc. Acad. Phil. **46**: 381. 1894. 18. *Cercospora callae* Pk. & Clint., (*524*), on *Peltandra virginica;* Collins Beach, June 13, 1887. 19. *Cercospora cana* Sacc., (*334*), on *Erigeron annuum;* Faulkland, Sept. 10, 1886. 20. *Cercospora cana* Sacc., (*2714*), on *Erigeron annuum;* Wilmington, July 2, 1895. 21. *Cercospora cana* Sacc., on *Erigeron* sp.; Newark, July 7, 1893 (= *Cercosporella cana* = *Ramularia cana* = *Fusidium cana*).

22. *Cercospora cephalanthi* E. & K., (*678*), on *Cephalanthus occidentalis;* Faulkland, Oct. 3, 1887, Jour. Myc. **4**: 5. 1888. 23. *Cercospora cephalanthi* E. & K., (*190*), on *Cephalanthus occidentalis;* Salem City, N. J., Sept. 1, 1885. 24. *Cercospora chenopodii* Fres., (*157*), on *Chenopodium album;* Faulkland, Aug. 26, 1885. 25. *Cercospora chenopodii* Fres., (*157*), on *Chenopodium album;* Faulkland, Sept. 10, 1885. 26. *Cercospora chenopodii* Fres., (*157*), on *Chenopodium album;* Stanton, Sept. 10, 1885. 27. *Cercospora chenopodii* Fres., (*304*), on *Chenopodium urbicum;* Faulkland, Aug. 16, 1886. 28. *Cercospora circumscissa* Sacc., (*148*), on *Prunus cerasus;* Faulkland, Sept. 9, 1885. 29. *Cercospora clavata* (Ger.) Pk., (*651*), on *Asclepias incarnata;* Wilmington, Oct. 22, 1889. 30. *Cercospora clavata* (Ger.) Pk., (*651*), on *Asclepias cornuti;* Faulkland, Aug. 25, 1887. 31. *Cercospora condensata* E. & K., (*130*), on *Gleditsia triacanthos;* Stanton, Sept. 10, 1885. 32. *Cercospora cruciferarum* E. & E. n. sp., (*249*), on *Sisymbrium officinale;* Faulkland, June 16, 1887, Jour. Myc. **3**: 17. 1887. Note: Also collected at same place, Aug. 1, 1886. 33. *Cercospora daturae* Pk., (*668*), on *Datura Stramonium;* Faulkland, Sept. 22, 1887.

34. *Cercospora demetriana* Wint., (*272*), on *Crotalaria sagittalis;* Faulkland, Aug. 2, 1886. 35. *Cercospora desmodii* E. & K., on *Desmodium viridiflorum;* Centerville, Sept. 16, 1865. 36. *Cercospora deutziae* E. & E. n. sp., (*199*), on *Deutzia gracilis;* Faulkland, Sept. 9, 1885, Jour. Myc. **4**: 5. 1888. Note: Also collected at same place, Nov. 4, 1885. 37. *Cercospora diantherae* E. & K., (*2528*), on *Dianthera americana;* Delaware City, Aug. 17, 1894. 38. *Cercospora diodiae* Cke., (*273*), on *Diodia teres;* Faulkland, Aug. 1886. 39. *Cercospora dioscoreae* E. & M., (*373*), on *Dioscorea villosa;* Mt. Cuba, Aug. 19, 1886. Note: Two other specimens, one from Faulkland and one from Wilmington. 40. *Cercospora echinocystis* E. & M., (*171*), on *Sicyos angustatus;* Faulkland, Sept. 10, 1885. 41. *Cercospora effusa* B. & C., (*2315*), on *Lobelia syphilitica;* Wilmington, Oct. 9, 1893.

42. *Cercospora elephantopidis* E. & E. n. sp., (*75*) and (*218*), on *Elephantopus carolinianus;* Faulkland, Sept. 27, 1885, Jour. Myc. **3**: 15. 1887. Note: The original spelling is *elephantopi.* 43. *Cercospora ferruginea* Fckl., (*1619*), on *Lobelia puberula;* Wilmington, Sept. 28, 1890. 44. *Cercospora ferruginea* Fckl. (*132*), on *Ambrosia trifida;* Faulkland, Sept. 8, 1885. Note: There are two more unnumbered specimens from same place. 45. *Cercospora flagellaris* E. & M., (*237*), on *Phytolacca decandra;* Faulkland, Sept. 27, 1885. Note: Another specimen (*624*) from the same place. 46. *Cercospora galii* E. & Holw., (*290*), on *Galium pilosum;* Faulkland, Aug. 13, 1886. 47. *Cercospora gentianicola* E. & E. n. sp., (*128*), on *Gentiana crinita;* Faulkland, Oct. 17, 1887, Jour. Myc. **4**: 2. 1888. 48. *Cercospora gnaphaliaceae* Cke., (*2444*), on *Gnaphalium purpureum;* Smyrna, June 18, 1894. Note: Also specimen from Faulkland, number *627.* 49. *Cercospora granuliformis* E. & Holw., (*33*), on *Viola cucullata;* Faulkland, July 16, 1885. 50. *Cercospora heucherae* E. & M., (*322*), on *Heuchera americana;* Wilmington, Oct. 22, 1889. 51. *Cercospora heucherae* E. & M., (*1205*), on *Heuchera americana;* Wilmington, Feb. 5, 1890. 52. *Cercospora houstoniae* E. & E. n. sp., (*1371*), on *Houstonia coerulea;* Wilmington, Apr. 28, 1890, Proc. Acad. Phila. **43**: 89. 1891. 53. *Cercospora hydrocotylis* E. & E., (*2568*), on *Hydrocotyle umbellata;* Pennsville, N. J., Sept. 17, 1894. 54. *Cercospora infuscans* E. & E. n

sp., (*1621*), on *Rhus venenata;* Porters Station, Oct. 9, 1890, Proc. Acad. Phila. **43**: 90. 1891. 55. *Cercospora infuscans* E. & E., (*1621*), on *Rhus venenata;* Newark, Oct. 10, 1893. 56. *Cercospora leptosperma* Pk., (*324*), on *Aralia nudicaulis;* Mt. Cuba, Aug. 19, 1886. 57. *Cercospora lini* E. & E. n. sp., (*248*), on *Linum virginianum;* Faulkland, Sept. 1886, Jour. Myc. **3**: 16. 1887. Note: Also two other specimens. 58. *Cercospora liquidambaris* E. & E., (*1005*), on *Liquidambar styracifolia;* Wilmington, Sept. 20, 1889. 59. *Cercospora monoica* E. & Holw., (*32*), on *Amphicarpa monoica;* Faulkland, July 13, 1885. 60. *Cercospora nesaeae* E. & E. n. sp., (*1984*), on *Nesaea verticillata;* Milford, Sept. 1, 1892, Proc. Acad. Phila. **45**: 170. 1893. 61. *Cercospora nesaeae* E. & E., (= *1984*), on *Nesaea verticillata;* Delaware City, Aug. 17, 1894. 62. *Cercospora nymphaeaceae* C. & E., (*2730*), on *Nymphaea advena;* Rehoboth City, Aug. 1, 1895. 63. *Cercospora nymphaeaceae* C. & E., (*300*), on *Nymphaea advena;* Wilmington, Sept. and Oct. 1894. 64. *Cercospora oculata* E. & K., (*109*), on *Vernonia noveboracensis;* Faulkland, Sept. 8, 1885. 65. *Cercospora oculata* E. & K., (*139*), on *Vernonia noveboracensis;* Faulkland, Aug. 15, 1885. 66. *Cercospora osmorrhizae* E. & E. n. sp., (*1416*), on *Osmorrhiza longistylis;* Wilmington, May 29, 1890, Proc. Acad. Phila. **43**: 89. 1891. 67. *Cercospora pachyspora* E. & E. n. sp., (*1013* and *1014*), on *Alisma plantago;* Wilmington, Oct. 4, 1889, Proc. Acad. Phila. **43**: 88. 1891. 68. *Cercospora polygonacea* E. & E., (*159*), on *Polygonum dumetorum;* Faulkland, Aug. 25, 1885. 69. *Cercospora polygonacea* E. & E., (*167*), var. *avicularis*, on *Polygonum aviculare;* Faulkland, Aug. 25, 1885.

70. *Cercospora polygonorum* Cke., (*169*), on *Polygonum sagittatum;* Faulkland, Sept. 12, 1885. 71. *Cercospora polygonorum* Cke., (*118*), on *Polygonum aviculare;* Faulkland, Aug. 15, 1885. 72. *Cercospora polygonorum* Cke., (*168*) and (*162*), on *Polygonum persicaria;* Faulkland, Sept. 12, 1885. Note: This may be *Cercospora hydropiperis* (Thum.) Speg. 73. *Cercospora racemosa* E. & M., (*277*), on *Teucrium canadense;* Faulkland, Oct. 12, 1885. 74. *Cercospora rhuina* C. & E., (*86*), (*57*) and (*56*), on *Rhus glabra;* Faulkland, Aug. 6, 1885. 75. *Cercospora rhuina* C. & E., on *Rhus glabra;* Wilmington, July 3, 1894. 76. *Cerco-*

spora sabbatiae E. & E. n. sp., (*589*), on *Sabbatia angularis;* Faulkland, Aug. 2, 1887, Jour. Myc. **4**: 3. 1888. 77. *Cercospora sagittariae* E. & K., (*221*), on *Sagittaria variabilis;* Faulkland, Aug. 2, 1886. 78. *Cercospora sagittariae* E. & K., (*321*), on *Sagittaria variabilis;* Wilmington, Sept. 4, 1889. 79. *Cercospora sagittariae* E. & K., (*2572*), on *Sagittaria variabilis;* Delaware City, Sept. 18, 1894. 80. *Cercospora sanguinariae* Pk., (*2746*) and (*6*), on *Sanguinaria canadensis;* Faulkland, June 12, 1885. 81. *Cercospora senecionis* E. & E. n. sp., (*978*), on *Senecio aureus;* Wilmington, Nov. 1, 1889, Proc. Acad. Phila. **43**: 90. 1891. 82. *Cercospora serpentaria* E. & E. n. sp., (*337*), on *Aristolochia serpentaria;* Faulkland, Sept. 11, 1886, Jour. Myc. **3**: 13. 1887. 83. *Cercospora simulata* E. & E., (*381*), on *Cassia Marylandica;* Faulkland, Sept. 26, 1886. 84. *Cercospora smilacina* Sacc., on *Smilax glauca;* Sept. 7, 1892. 85. *Cercospora smilacis* Thum., (*63*), on *Smilax glauca;* Faulkland, July 23, 1885. 86. *Cercospora smilacis* Thum., (*761*), on *Smilax rotundifolia;* Faulkland, Nov. 18, 1887. 87. *Cercospora squalidula* Pk., (*461*), on *Clematis virginiana;* Faulkland, Oct. 8, 1886. 88. *Cercospora Stylosanthes* E. & E. n. sp., (*336*), on *Stylosanthes elatior;* Faulkland, Sept. 17, 1886, Jour. Myc. **3**: 13. 1887. Note: Possibly the same as *Cercospora Commonsii.* 89. *Cercospora symplocarpi* Pk., (*98*), on *Symplocarpus foetidus;* Faulkland, Aug. 15, 1885. Note: Three other collections from different places. 90. *Cercospora thaspii* E. & E. n. sp., (*1034*), on *Thaspium trifoliatum;* Wilmington, Oct. 23, 1889. Note: Found no publication. 91. *Cercospora tuberosa* E. & K., (*673*), on *Apios tuberosa;* Faulkland, Sept. 30, 1875. 92. *Cercospora verbasicola* E. & E. n. sp., (*669*), on *Verbascum thapsus;* Faulkland, Aug. 26, 1887, Jour. Myc. **4**: 3. 1888. 93. *Cercospora violae* Sacc., (*236*), on *Viola cucullata;* Faulkland, Sept. 29, 1885. 94. *Cercospora* sp., (*672*), on *Rhyncosia tomentosa;* Aug. 5, 1874. 95. *Cladosporium carpophyllum* Thum., (= *321*), on peaches; Wilmington, Sept. 1889. 96. *Cladosporium dendriticum* Wallr., (*12*), on apple; Faulkland, Jan. and Feb. 1886. 97. *Cladosporium epimyces* Cke., (*1879*), on *Polyporus;* Wilmington, Oct. 26, 1891.

98. *Cladosporium epimyces* Cke., (*480*), on *Agaricus;* Faulkland, March 9, 1887. 99. *Cladosporium epiphyllum* Pk., (*1379*),

on leaf; Wilmington, April 28, 1890. 100. *Cladosporium fulvum* Cke., (*2378*), on *Lycopersicum;* Wilmington, Nov. 28, 1883. 101. *Cladosporium graminum* Cke., (*2060*), on *Carex torta;* Naaman's Creek, July 10, 1893. 102. *Cladosporium graminum* Cke., (*30*), on *Carex* sp.; Faulkland, July 22, 1885. 103. *Cladosporium herbarum* (Pers.) Lk., (*1772*), on *Asclepias cornuti;* Wilmington, May 5, 1891. 104. *Cladosporium typharum* Desm., (*2208*), on *Typha latifolia;* Wilmington, Aug. 25, 1893. 105. *Cladosporium* sp., (*91*), on *Barbarea vulgaris;* Greenbank, July 17, 1886. 106. *Clasterosporium caespitulans* E. & E., on rotten wood; Newfields, N. J., 1879. 107. *Clasterosporium Commonsii* E. & E. n. sp., (*127*), on dead bark; Wilmington, Dec. 12, 1889. Note: Found no publication. 108. *Clasterosporium populi* E. & E. n. sp., (*1806*), on *Populus grandidentata;* Carrcroft, Aug. 16, 1891, Jour. Myc. **7**: 134. 1894.

109. *Dendrina diospyri* B. & C., (*1585*), on *Diospyrus virginiana;* Wilmington, Sept. 18, 1890. Note: Possibly a *Trichosporium*. 110. *Fusella polyporina* E. & E. n. sp., (*2728*), on *Fomes lucidus;* Selbyville, July 18, 1895. Note: Found no publication. 111. *Fusicladium dendriticum* (Wallr.) Fckl., (*154*) and (*55*), on apple; Faulkland, Aug. 25, 1885. 112. *Fusicladium staticis* E. & E. n. sp., (*2565*), on *Statice limonum;* Cape May, N. J., Sept. 13, 1894, Proc. Acad. Phila. **46**: 378. 1894. 113. *Glenospora Curtisii* Berk., (*494*), on *Nyssa multiflora;* Faulkland, May, 1887. 114. *Glenospora Curtisii* Berk., on *Nyssa multiflora;* Wilmington, Dec. 19, 1889. 115. *Glenospora Curtisii* Berk., on *Nyssa multiflora;* Faulkland, Feb. 1887. Note: Possibly *Dematium ramorum*. 116. *Gymnosporium arundinis* Cda., (*1816*), on *Panicum* sp. Note: Possibly *Coniosporium arundinis* (Cda.) Sacc. 117. *Helminthosporium arctisporum* C. & E., (*1447*), on *Vaccinium corymbosum;* Wilmington, May 29, 1890. 118. *Helminthosporium hadotrichoides* E. & E. n. sp., (*347*), on *Eragrostis major;* Sept. 15, 1887, Jour. Myc. **4**: 44. 1888. 119. *Helminthosporium interseminatum* B. & R., (*1134*), on *Phytolacca decandra;* Wilmington, Jan. 1, 1890. 120. *Helminthosporium macrocarpum* Grev., (*1249*), on *Liriodendron tulipiferae;* Wilmington, Feb. 18, 1890. 121. *Helminthosporium macrocarpum* Grev., (*1384*), on *Magnolia glauca;* Wilmington, Feb. 3, 1890.

122. *Helminthosporium persistens* C. & E., (*2018*), on oak bark; Naaman's Creek, Nov. 14, 1892. 123. *Helminthosporium pirorum* Lb., on apple; Faulkland, Aug. 1887. 124. *Helminthosporium tiliae* Fr., (*2124*), on *Tilia americana;* Mt. Cuba, June 28, 1893. 125. *Helminthosporium variegatum* E. & E., (*1243*), on oak sapling; Wilmington, Feb. 18, 1890. 126. *Helminthosporium* sp., (*2086*), on *Salix humilis;* Newark, July 7, 1893. 127. *Helminthosporium* sp., (*60*), on *Solidago lanceolata;* Faulkland, Oct. 11, 1885. Note: "I have seen this before but I think it has never been named." J. B. E.

128. *Macrosporium avicennae* E. & E. n. sp., (*1586*), on *Abutilon avicennae;* Wilmington, Sept. 9, 1890. Note: Found no publication. 129. *Macrosporium commune* Rab., (*1936*), on *Dianthus* sp.; Wilmington, Apr. 26, 1892. 130. *Macrosporium cydoniae* E. & E. n. sp., (*2445*), on quince; Pensauken, June 12, 1894. Note: Found no publication. 131. *Macrosporium herculeum* E. & M., (*243*), on *Nasturtium armoracea;* Pennsgrove, N. J., July 13, 1886. 132. *Macrosporium iridis* E. & M., (*1230*), on *Iris* sp.; Wilmington, Dec. 24, 1889. 133. *Macrosporium maculatum* C. & E., (*110*), on *Zea mays;* Faulkland, Aug. 21, 1885. 134. *Macrosporium maydis*, (*110* and *210*), on *Zea mays;* Faulkland, Aug. 20 and 21, 1885. 135. *Macrosporium nobile* Vize., (*2385*), on *Dianthus* sp.; Wilmington, Nov. 28, 1893. 136. *Macrosporium* sp., (*630*), on *Asclepias cornuti;* Faulkland, Aug. 18, 1887. 137. *Macrosporium* sp., (*2421*), on *Trifolium incarnatum;* Pleasant Hill, May 28, 1894. 138. *Macrosporium* sp., (*680*), on *Maclura aurantiaca;* Faulkland, Oct. 3, 1887. Note: Also *Phoma* on this host. 139. *Macrosporium* sp., (*1778*), on *Ailanthus glandulosa;* Wilmington, Apr. 1, 1891. 140. *Macrosporium* sp., (*200*), on?; Faulkland, Sept. 9, 1885. Note: "I do not like to make any more species." J. B. E. 141. *Macrosporium* sp., (*2035*), on *Sarracenia purpurea;* Laurel, June 15, 1893. 142. *Macrosporium* sp., (*630*), on *Asclepias;* Aug. 18, 1886. Note: Same as number *136*. 143. *Periconia byssoides* Pers., (*346*), on *Commelina nudiflora;* Faulkland, Sept. 17, 1886. Note: Possibly same as *Sporocybe byssoides* Fr. 144. *Periconia minutissima* Cda., (*938*), on *Morus alba;* Wilmington, Aug. 2, 1889. 145. *Periconia pycnospora* Fres., (*2138*), on *Impatiens fulva;*

Wilmington, July 27, 1893. Note: Also numbers *2222, 2255, 2462, 2361, 2246, 1224.* 146. *Polythrincium trifolii* Kunze., (*35* and *318*), on *Trifolium repens;* Faulkland, Sept. 29, 1885. 147. *Scolecotrichum graminis* Fckl., (*519*), on *Dactylis glomerata;* Faulkland, June 12, 1887. 148. *Scolecotrichum graminis* Fckl., (*1886*), on *Muhlenbergia mexicana;* Pennsville, N. J., Oct. 15, 1891. 149. *Scolecotrichum graminis* Fckl., (*532*), on *Phleum pratense;* Faulkland, July 18, 1887. 150. *Septonema spilomeum* Berk., (*392* and *554*), on old boards; Faulkland, Sept. 21, 1886. 151. *Septonema spilomeum* Berk., (*944*), on *Morus alba;* Wilmington, July 22, 1889. 152. *Septosporium fuliginosum* Ell., (*1745*), on *Cornus florida;* Wilmington, May 5, 1890. 153. *Septosporium hadotrichoides* E. & E. n. sp., (*347*), on *Eragrostis major;* Faulkland, Sept. 17, 1886. Note: Jour. Myc. **4**: 44. 1888. Published as *Helminthosporium hadotrichoides.* 154. *Sporodesmium antiquum* Cda., (*985*), on *Platanus occidentalis;* Wilmington, 1889, 1891. 155. *Sporodesmium concinnum* Berk., (*2020*), on old wood; Carrcroft, Dec. 4, 1892. Note: Also numbers *2252, 1741.* 156. *Sporodesmium conglobatum* C. & E., (*1652*), on *Quercus palustris;* Wilmington, Oct. 31, 1890. 157. *Sporodesmium hysterroideum* C. & E., (*1995*), on *Juniperus virginiana;* Wilmington, Oct. 29, 1892. 158. *Sporodesmium lepraria* B. & Br., (*2021*), on decayed wood; Carrcroft, Dec. 4, 1892. 159. *Sporodesmium peziza* C. & E., (*1212*), on *Cornus florida;* Wilmington, Feb. 5, 1890. 160. *Sporodesmium peziza* C. & E., (*2081*), on *Tilia* sp.; Mt. Cuba, June 22, 1893. 161. *Streptothrix atra* B. & C., (*1201*), on *Vaccinium corymbosum;* Wilmington, Jan. 2, 1890. 162. *Streptothrix atra* B. & C., (*1905*), on *Juniperus virginiana;* Wilmington, Dec. 5, 1891. 163. *Torula binalis* C. & E., (*731*), on willow; Faulkland, Oct. 17, 1887. 164. *Torula Fuckelii* Sacc., (*1192*), on *Salix fragilis;* Wilmington, Feb. 5, 1890. 165. *Torula herbarum* Lk., (*2139*), on *Impatiens fulva;* Mt. Cuba, July 27, 1893. 166. *Zygodesmus bicolor* C. & E., (*2454*), on *Clavaria* sp.; Wilmington, June 23, 1894. 167. *Zygodesmus fuscus* Cda., (*716*), on bark; Faulkland, Oct. 15, 1887.

FAMILY STILBACEAE. 1. *Podosporium rigidum* Schw., (*2339*), on *Rhus toxicodendron;* Wilmington, Oct. 7, 1893. 2. *Stilbum aurifilum* Ger., (*2666*), on *Corticium* (*Stereum*) sp., Wilmington,

Nov. 15, 1894. 3. *Stilbum erythrocephalum* Detm. (*1470*), on animal dung; Newark, June 27, 1890. 4. *Stilbum parvulum* C. & E., (*2286*), on *Acer rubrum;* Wilmington, Sept. 30, 1893. 5. *Stilbum rhoidis* B. & C., (*1099*), on *Rhus glabra;* Wilmington, Dec. 3, 1889. 6. *Stilbum rhoidis* B. & C., (*1403*), on *Diospyros virginiana;* Wilmington, Jan. 28, 1890. 7. *Stilbum tomentosum* Schrad., (*1364*), on moss; Wilmington, April 2, 1890.

FAMILY TUBERCULARIACEAE. 1. *Aegerita candida* Pers., (*791*), on leaves; Faulkland, Dec. 8, 1887. 2. *Dendrodochium affinis* Sacc., (*953*), on *Euphorbia* sp.; Wilmington, Aug. 13, 1887. Note: Mixed with *Vermicularia compacta* C. & E. 3. *Dendrodochium densipes* Sacc. & Ell., (*1595*), on *Salix;* Wilmington, Aug. 19, 1890, Jour. Myc. **4**: 117. 1888. Note: Original description based on Commons collection No. *639*. 4. *Dendrodochium rubellum* Sacc., (*2182*), on *Platanus occidentalis;* Naaman's Creek, July 28, 1893. 5. *Dendrodochium pezizoides* E. & E. n. sp., (*2234*), on *Triticum vulgare;* Newark, Sept. 8, 1893. Note: Found no publication. 6. *Dendrodochium serratum* E. & E. n. sp., (*739*), on cedar bark; Faulkland, Oct. 24, 1887. Note: Found no publication. 7. *Dendrodochium succineum* E. & E. n. sp., (*1914*), on decayed wood; Laurel, Feb. 24, 1892. Note: Found no publication. 8. *Epicoccum negundinis* E. & E. n. sp., (*2232*), on *Negundo aceroides;* Grenogue, Aug. 18, 1893. Note: Found no publication. *Epicoccum negundinis* Otth. in Bern. Mittheil. 1879, seems to antedate Ellis' name. 9. *Epicoccum neglectum* Desm., (*1075*), on *Panicum crus-galli;* Wilmington, Nov. 5, 1889. 10. *Epicoccum neglectum* Desm., (*2362*), on *Scirpus lacustris;* Wilmington, Nov. 1, 1893. Note: Also seven other numbers. 11. *Epicoccum nigrum* Lk., (*2375*), on *Typha latifolia;* Wilmington, Nov. 6, 1893. 12. *Epicoccum purpurascens* Ehrbg., (*952*), on *Scirpus lacustris;* Wilmington, Aug. 13, 1889. 13. *Epicoccum purpurascens* Ehrbg., (*1910*), on *Lycogala epidendrum;* Wilmington, Nov. 24, 1891. 14. *Epicoccum purpurascens* Ehrbg., (*211*), on *Zea mays;* Faulkland, Sept. 8, 1885. 15. *Epicoccum scabrum* Cda., (*2582*), on wood; Wilmington, Sept. 25, 1894. 16. *Epicoccum vulgare* Cda., (*1220*), on *Euonymus americana;* Wilmington, Mar. 24, 1890. 17. *Epicoccum vulgare* Cda., (*1231*), on *Iris;* Wilmington, Dec. 24, 1889. Note: Also number

2385. 18. *Fusarium aurantiacum* (Lk.) Sacc., (*1468*), on *Zygadenus helmanthoides;* Newark, June 27, 1890. 19. *Fusarium episphaericum* (C. & E.) Sacc., (*2245*), on *Carya;* Wilmington, Sept. 2, 1893. Note: Originally described as *Fusisporium episphaericum*. With this specimen is associated *Nectria bicolor* E. & E. n. sp., Proc. Acad. Phila. **45**: 443. 1893. The *Fusarium* is the conidial stage. 20. *Fusarium granulosum* E. & E. n. sp., (*2091*), on *Smilax hispida;* Mt. Cuba, June 28, 1893, Proc. Acad. Phila. **45**: 466. 1893. 21. *Fusarium rimosum* (Pk.) Sacc., (*1623*), on corn stalk; Wilmington, Oct. 11, 1890. Note: Originally described as *Fusisporium rimosum*. 22. *Fusarium roseum* Lk., (*1138*), on *Phytolacca decandra;* Wilmington, Jan. 27, 1890. Note: Also numbers *1062* and *973*. 23. *Fusarium Schweinitzii* Ell. & Hark., (*1311*), on *Vitis* sp.; Wilmington, Jan. 18, 1890. 24. *Fusarium* sp., (*2591*), on beans; Wilmington, Oct. 2, 1894. 25. *Hymenopsis trochiloides* Sacc., (*2316*), on *Scirpus lacustris;* Wilmington, Oct. 9, 1893. Note: Also numbers *2317, 2209, 2757, 2210*. 26. *Illosporium pallidum* Cke., (*1287*), on leaves; Wilmington, Dec. 19, 1889. 27. *Illosporium panduratum* E. & E. n. sp., (*2277*), on *Boletinus porosus;* Wilmington, Sept. 3, 1893. Note: Found no publication. 28. *Myrothecium inundatum* Sacc., (*601*), on the ground; Faulkland, Aug. 8, 1887. 29. *Myrothecium inundatum* Sacc., (*1817*), on agaric; Wilmington, Sept. 7, 1891. 30. *Sphaerosporium lignatile* Schw., on *Fraxinus americana;* Wilmington, Oct. 18, 1890. Note: Considered a doubtful genus. 31. *Trimmatostroma americana* Thum., (*1690*), on *Salix;* Wilmington, Nov. 1, 1890. 32. *Tuberculariа menispermii* Schw., (*395*) and (*345*), on *Menispermum canadense;* Faulkland, Oct. 6, 1886. 33. *Tubercularia nigricans* (Bull.) Lk., (*508*), on *Fraxinus americana;* Faulkland, Mar. 20, 1887. 34. *Tubercularia vulgaris* Tode., (*2265*), on dead stem; Mt. Cuba, Sept. 20, 1893. Note: Many other collections.

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SPECIES OF SYNCHYTRIUM IN LOUISIANA. V. A NEW SPECIES ON SAMBUCUS CANADENSIS

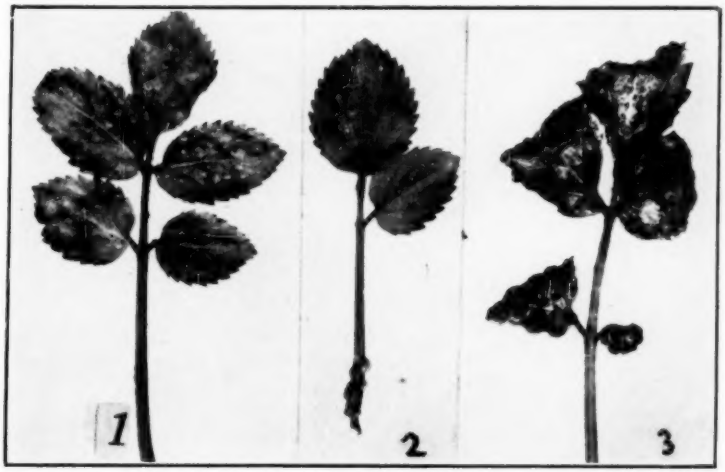
MELVILLE T. COOK

(WITH 9 FIGURES)

This species was found on the young leaves of young plants that were not more than six inches in height and growing in wet, usually muddy, soil. Infected plants growing in a dry environment were infected before the subsidence of the water and drying of the soil. The galls were most abundant on the under surfaces of the leaves but were found to some extent on the petioles and rarely on the upper surfaces of the leaves (FIGS. 1, 2, 3). The infections started as small, green spots in which small, bright green, hemispherical galls are formed. In the later stages, these galls were large and usually conical with a pit or crater-like cavity in the center (FIG. 8). The infected cell was at the bottom of a crater. The mature gall rested almost or entirely on the surface of the leaf or petiole but in some cases the basal part was embedded in the host tissues (FIG. 8).

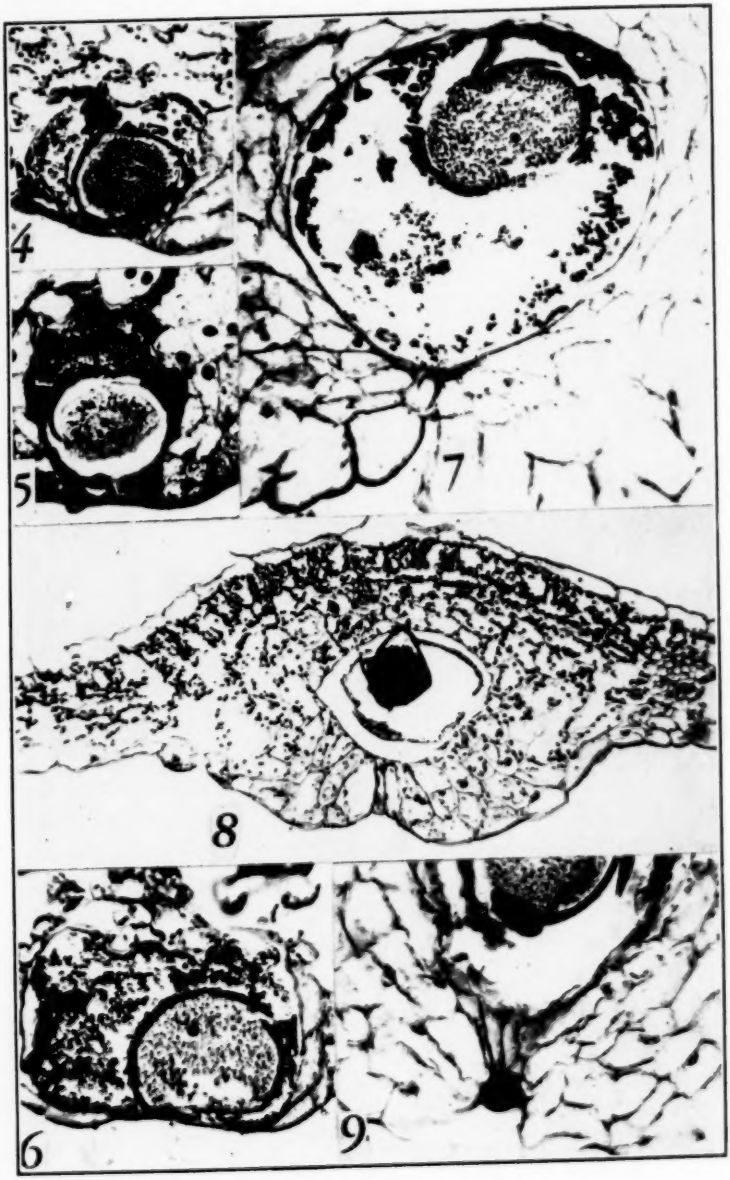
The infections were in young epidermal cells (FIG. 4) as in all other species studied by the writer. The infected cells grew rapidly. The galls were formed by a growth of the epidermal and mesophyll cells surrounding the infected epidermal cells. The cells composing the galls may or may not be elongated (FIGS. 7, 8). When the galls were partly submerged, the cells of the host tissues were more or less modified (FIG. 8). When the galls were numerous they caused a more or less pronounced deformity of the leaf or petiole (FIG. 3). In some few cases, the epidermal cells of a new gall became infected which resulted in a pronounced compound gall. In some cases a second zoöspore endeavored to penetrate the infected cell through the opening in the cone. If it failed to do so, it increased in size for a time and died (FIG. 9).

The fungus was very light lemon color at first, became yellow, orange, and brown with age and was visible at the bottom of the crater at a very early period in the development of the gall. It filled the host cell in a very short time (FIG. 4). In many cases the fungus died and turned black before maturity. After a time the infected cell grew more rapidly than the fungus, which did not completely fill the host cell (FIGS. 5, 6, 7). The fungus was granular with a well defined nucleus. The segmentation of the



FIGS. 1–3. *Synchytrium sambuci.*

fungus to form sporangia was not observed. Many dead, empty galls were seen and the writer is of the opinion that the fungus became separated from the gall before the formation of the sporangia. The fungus grew rapidly and was surrounded by granular material or modified host cell contents which became modified into a dense granular or solid substance (FIGS. 5, 6). The infected cells were pear shaped (FIG. 7) or irregular (FIGS. 5, 6). In the latter case the contents of the cell appeared to be amoeboid but there was no evidence of disintegration of cell walls of the host plant. The host cell nucleus is very definite and occasionally two host nuclei are present. The host nuclei may or may not be attached to the nucleus. Occasionally two fungi were found in the



FIGS. 4–9. *Synchytrium sambuci.*

same host cell. The fungus was usually surrounded by a hard wall which appeared to be composed of three layers, which break very easily (FIGS. 6, 7).

Synchytrium sambuci sp. nov.

Gallis numerosis in utraque foliorum superficie atque in petiolis; simplicibus, plerumque ampullaceis, superficie nixis vel in textu sitis, 75–100 μ diametro. Soris primo subflavissimis, aetate in colorem flavum, aurantiacum et brunneum se mutantibus, circa 135 μ diametro.

The author wishes to express his thanks to Dr. C. W. Edgerton for suggestions and for making the photographs, to Dr. P. J. Moorhead, who translated the description into Latin, and to Mr. W. J. Dickson, who found and collected the material.

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EXPLANATION OF FIGURES

FIGS. 1, 2. Single galls on leaves and petioles. 3. Leaf deformed by galls. 4. Infected epidermal cell showing fungus and host cell contents. 5. More advanced stage showing irregular host cell. 6. More advanced stage showing large host cell. 7, 8. More advanced stage showing opening to host cell. 7. A gall in which the tissues of the host are only slightly modified. 8. A gall in which the infected cell is partly submerged in the tissues of the leaf. 9. A gall showing a second enlarged spore trying to gain entrance.

OLPIDIOPSIS SCHENKIANA AND ITS HYPERPARASITE ECTROGELLA BESSEYI N. SP.

F. K. Sparrow and Bernard Ellison [1]

(with 1 figure)

Late in November, 1945, a purple sediment was noticed on the bottom of an unfrozen pond (water temperature 6° C.) in the vicinity of Ann Arbor, Michigan. An examination of this material showed it to consist primarily of a colonial purple bacterium and occasional filaments of a one-banded, replicate-walled species of *Spirogyra*. Of particular interest was the fact that the alga was heavily parasitized by a phycomycetous fungus, readily recognizable as *Olpidiopsis Schenkiana* Zopf. Thalli, zoosporangia, and sex organs of the parasite were relatively plentiful in the algal filaments. A closer inspection of the material revealed a fact of unusual interest, namely, that the algal parasite was, in turn, parasitized by an endoparasite which, like its host, was also a phycomycete.

Olpidiopsis Schenkiana is well known from the classic researches of Zopf (**13**), and since his original discovery of the fungus it has been collected a number of times in Europe (**2, 3, 4, 6, 8, 11, 12**), once in India (**1**), and has been mentioned by Karling (**5**) as occurring in the vicinity of New York. Because of paucity of information concerning the species in the Western Hemisphere and because the presence of an endoparasite—apparently a new species—serves to offer an explanation of certain puzzling figures which have appeared in the European literature of this fungus, its occurrence in Michigan has seemed worthy of note.

[1] Contribution No. 884 from the Department of Botany, University of Michigan.

OLPIDIOPSIS SCHENKIANA

Stages in the infection of the algal cell were not found in our material. They have, however, been excellently described by Zopf (l.c.). Very early in the development of the thallus, the chloroplast of the alga contracts and undergoes a progressive dissolution. Destruction is initiated in the immediate vicinity of the young thallus and the chloroplast and nucleus are very soon fragmented. The parts of the chloroplast become noticeably narrower, lobed and constricted, as indicated in FIG. A. As destruction continues, the two halves of the chloroplast seem drawn towards the fungus thallus and destroyed. Ultimately, the entire structure is reduced to an irregular, hyaline, gelatinous-appearing mass lying close to and extending out from either side of the body of the parasite. Whatever substance is active in the disintegration of the chloroplast is apparently of great potency and readily diffusable from cell to cell, since chloroplasts in cells remote from the infected one, but in the same filament, are obviously affected. These in contrast to chloroplasts in nearby, uninfected filaments, are distorted and contracted. Furthermore, the bright green color is soon changed to a yellow-green. Contraction and discoloration of the chloroplasts of entire filaments were so constantly associated in our material with infection by the *Olpidiopsis* that when such algal plants were found, one could be absolutely certain that somewhere in the filament there was a thallus of the fungus. This extreme and powerful toxicity is in striking contrast to the action of many pathogens of higher plants, such as leaf parasites, where the interloper actually seems to exert a preserving influence on cells not immediately in the area of infection. There is no induced hyperplasia and usually little hypertrophy of the host cells. Occasionally, cells containing old parasites became somewhat enlarged in the region of the parasite, but this was not a typical reaction.

The young thallus is at first ellipsoidal; its cytoplasm is hyaline, glistening, and bears a few granules and vacuoles (FIG. A). As it becomes older, it increases in size, the protoplasm becomes granular, and there is formed a large central vacuole (FIG. B). Subsequently, a discharge tube develops which quickly grows

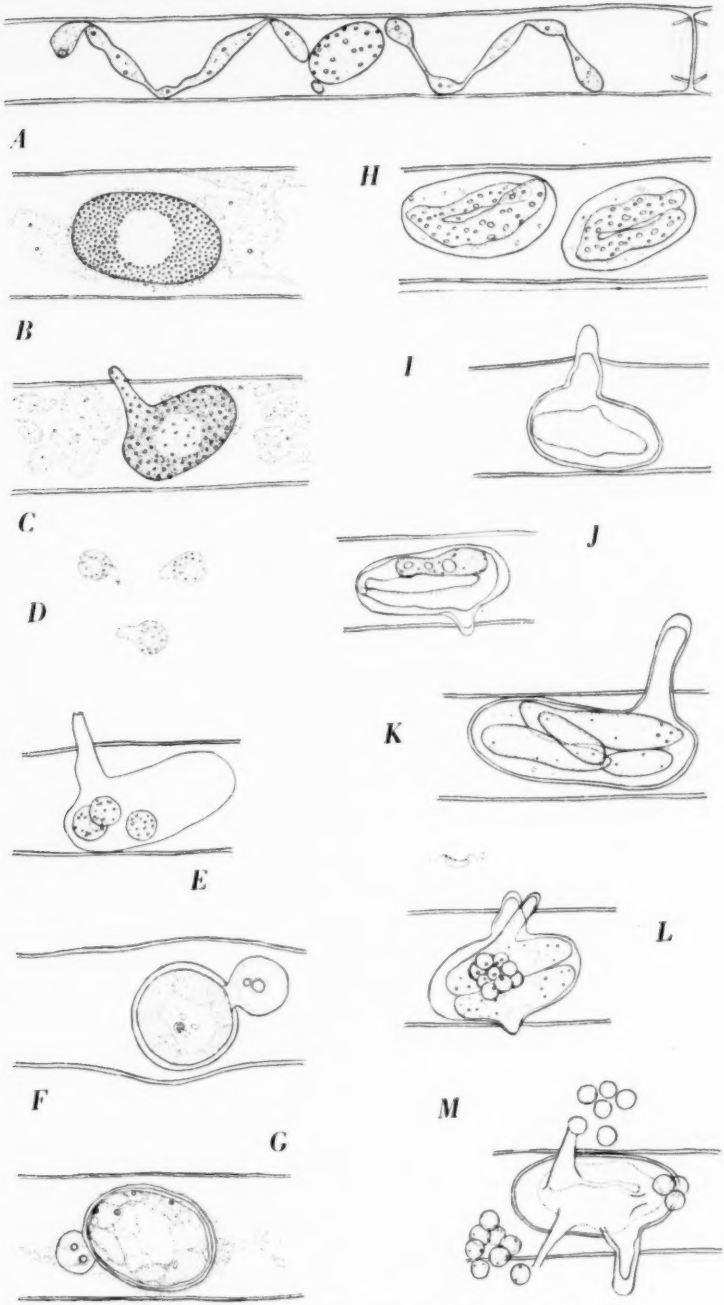

FIG. 1. *Olpidiopsis Schenkiana* and *Ectrogella Besseyi*.

through the wall of the *Spirogyra* cell (FIG. C). Cleavage of the contents of the sporangium into zoospores was not observed. It was noted, however, that the process took place before deliquescence of the tip of the single stout discharge tube. Zoöspore discharge in our material tended to support the claims of previous observers, including Zopf, that the zoöspores swim away without encystment. To be sure, there may be a period of amoeboid activity at the mouth of the tube, but there was no evidence that the spores ever encysted, as in *Achlya*, to emerge later as motile bodies, as Scherffel (8) has stated sometimes occurs. Observations on the hyperparasite, to be described later, may serve to explain this apparent discrepancy. The zoöspores are of the laterally biflagellate type, $8 \times 6\ \mu$, with unequal, oppositely directed flagella. In addition to swimming, they may undergo periods of marked amoeboid movement (FIG. D). Occasionally they may become quiescent in the sporangium, after having failed to escape at the moment of discharge (FIG. E).

Resting spore formation was also observed. Formation of these bodies is preceded by a sexual process entirely similar to that found in other species of the genus and involves the conjugation of two thalloid gametangia. One, the receptive thallus, after receiving the contents of the other, steadily enlarges and becomes invested with a somewhat thickened, smooth wall (FIGS. F, G). An irregular, large central vacuole forms in the content which, in our material, occasionally tended to pull away from the resting spore wall (FIG. G). According to Zopf, this resting structure becomes converted into a zoösporangium at germination.

A diagnosis of the Michigan material is included here.

Olpidiopsis Schenkiana Zopf. Zoösporangium ellipsoidal, the long axis 32–41 μ, the short axis 17 μ; wall smooth, colorless, forming a single lateral stout discharge tube 15–17 μ in length which opens upon the deliquescence of a prominent papilla; zoöspores $8 \times 7\ \mu$, with two oppositely directed flagella, amoeboid after emergence but not encysting, soon swimming away. Resting spore spherical or more commonly somewhat ellipsoidal, 19–24 μ in longest diameter, with a thickened, hyaline, smooth wall which turns brownish with age; companion cell spherical, 10–10.6 μ in diameter, smooth-walled.

Parasitic in *Spirogyra* sp., vicinity of Ann Arbor, Michigan, November 27, 1945; Feb. 13, 1948.

THE HYPERPARASITE OF OLPIDIOPSIS

Among the sporangial material of *O. Schenkiana*, there were some which were obviously parasitized by another Phycomycete. This hyperparasite was present only in the vegetative and sporangial stages.

From one to four thalli were found in a single sporangium of the host. When developing singly, the body was asymmetrical and bilobed (FIGS. H, J) whereas when more than one was present, the lobing tended to be suppressed and the shape ellipsoidal (FIG. K). The contents of the immature thallus were hyaline and bore numerous small vacuoles. At maturity, it becomes converted into a single zoösporangium bearing one to several narrow discharge tubes which penetrate the wall of both the host sporangium and the *Spirogyra* cell and extend for a varying distance outside in the water. The zoöspores are delimited within the sporangium, escape individually and rapidly, and, as in *Achlya*, encyst at once at the orifice of the discharge tube (FIG. M). After a variable period of encystment, usually less than an hour, they emerge as zoöspores of the secondary, biflagellate type (FIG. L). No further stages in the life history were observed.

It is quite evident from the figures in Scherffel's (**8**) and Domján's (**3**) papers that this hyperparasite was present in their material of *Olpidiopsis Schenkiana*. Scherffel has noted what he terms "secondary sporangia" within the empty sporangia of *Olpidiopsis*, and similar structures are shown by Domján. These are interpreted here as belonging to the hyperparasite. Furthermore, Scherffel's observations that the zoöspore discharge may sometimes be of the *Achlya* type can also be explained on the basis that he was actually observing this process in the hyperparasite.

The proper generic disposition of this fungus on the basis of thallus structure and non-sexual reproduction alone is difficult. Because of its tubular, lobed, or branched thallus, it strongly resembles a species of *Petersenia* or *Pontisma*. However, in these genera, zoöspore discharge is like *Olpidiopsis*, no *Achlya*-like

encysted spore stage occurring. In the Ectrogellaceae of the Saprolegniales, on the other hand, fungi are found which resemble closely the present one. In the genus *Ectrogella,* the thallus is tubular, or, as in the present fungus, if several are in a cell, ellipsoidal; the sporangia are provided with one to several discharge tubes. Furthermore, in zoöspore discharge there is a strong tendency for the emerged zoöspores to encyst immediately or very soon after escape. Comparison might also be made with *Aphanomycopsis.* Here, however, zoöspores are formed in only a single row in the sporangium, not a feature of our fungus.

In *Pythiella vernalis* Couch, a close resemblance is found to the *Spirogyra* parasite in both the manner of zoöspore discharge and host plant. Here, the zoöspores encyst at the orifice of the sporangium and later escape from the cysts as biflagellate structures. The fungus parasitizes *Pythium,* a filamentous Phycomycete. Our fungus differs from *Pythiella,* however, in having tubular, lobed sporangia rather than spherical ones. If resting spores had been present, the generic affinities of the *Olpidiopsis* parasite could be decided with more certainty. Until these are found and their method of formation studied, the generic disposition of our fungus is in some doubt. It seems best at this time to include it in *Ectrogella.*

By reason of the striking difference in host plant of our fungus from the algal-inhabiting species of *Ectrogella,* it is considered a new species. In naming it, we have chosen to honor one who has always had a keen interest in aquatic Phycomycetes, Ernst A. Bessey.

Ectrogella Besseyi sp. nov. Sporangia irregulariter tubularia, saepe lobata, interdum ellipsoidalia, longitudine 27–42 μ, diametro 13–17 μ, singula vel pauca in cellulis *Olpidiopsidis Schenkianae,* tubulas zoosporis emittientibus singulas vel multas formantia longitudine variantes; zoosporis numerosis, intra sporangia obviis, demum liberis et indurescentibus in gregibus immobilibus ad tubi emittientis aperturam, ex cellula induriuscula emergentibus ut zoosporis biflagellatis, 5 μ longis, 2.5 μ crassis; sporis perdurantibus non visis.

Parasitica in thallis et sporangiis *Olpidiopsidis Schenkianae* Zopf, prope Ann Arbor, Michigan, Novem. 1945 et Feb. 1948.

Sporangium irregularly tubular, often lobed, sometimes ellipsoidal, 27–42 μ long by 13–17 μ in diameter, one to several in a host cell, forming one to several discharge tubes of varying length;

zoöspores numerous, delimited within the sporangium, upon discharge from the sporangium encysting and forming motionless clusters at the orifice of the discharge tube, emerging from the cyst as a laterally biflagellate zoöspore, $5 \times 2.5\ \mu$. Resting spores not observed.

Parasitic in thalli and sporangia of *Olpidiopsis Schenkiana* Zopf, vicinity of Ann Arbor, Michigan. November, 1945; February, 1948.

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LITERATURE CITED

1. **Butler, Edwin J.** 1907. An account of the genus *Pythium* and some Chytridiaceae. Mem. Dept. Agri. India, Bot. Ser. **1**: 1–160, pls. 1–10.
2. **Constantineanu, M. J. C.** 1901. Contributions à la flore mycologique de la Roumanie. Revue gén. Bot. **13**: 369–389, figs. 75–84.
3. **Domján, A.** 1936. "Vízigombas"—Adatok Szeged és Tihany Vidékéröl ("Wasserpilz"—daten aus der Umgebung von Szeged und Tihany). Folia cryptogam. **2** (1): 8–59, pl. 1.
4. **Fisch, Carl.** 1884. Beiträge zur Kenntniss der Chytridiaceen. Sitzungsber. Phys.-Med. Soc. Erlangen **16**: 29–72, pl. 1, 39 figs.
5. **Karling, J. S.** 1943. The simple holocarpic biflagellate Phycomycetes. 123 pp., illust. New York.
6. **Krenner, J. A.** 1935. Nehány adat hazánk gombaflórájához (Ein Beiträge zur Pilzflora Ungarns). Bot. Közl. **32**: 201.
7. **Minden, M. von.** 1911. Kryptogamenfl. Mark Brandenberg **5**: 257.
8. **Scherffel, A.** 1925. Endophytische Phycomyceten-Parasiten der Bacillariaceen und einige Neue Monadinen. Ein Beitrag zur Phylogenie der Oomyceten (Schröter). Arch. f. Protistenk. **52**: 1–141, pls. 1–5.
9. **Sparrow, F. K., Jr.** 1934. Observations on marine phycomycetes collected in Denmark. Dansk Bot. Ark. **8** (6): 1–24, 4 pls.
10. ——. 1943. Aquatic Phycomycetes exclusive of the Saprolegniaceae and *Pythium*. Pp. 1–785, 69 figs. University of Michigan Press. Ann Arbor, Michigan.
11. **Wildeman, É. de.** 1890. Chytridiacées de Belgique. Ann. Soc. Belge Micro. (Mém.) **14**: 5–28, 7 figs.
12. ——. 1896. Notes mycologiques VII. *Ibid.* **20**: 21–64, 1 text fig., pls. 1–3.
13. **Zopf, W.** 1884. Zur Kenntniss der Phycomyceten. I. Zur Morphologie und Biologie der Ancylisteen und Chytridiaceen. Nova Acta Acad. Leop.-Carol. **47**: 143–236, pls. 12–21.

EXPLANATION OF FIGURES

FIG. *A*. Young vegetative thallus of *O. Schenkiana* in *Spirogyra* cell. Chloroplast shows characteristic early stages of degeneration. *B*. Mature vegetative thallus of *O. Schenkiana* prior to formation of escape tube and zoöspores. *C*. Formation of zoöspore escape tube by *O. Schenkiana*. *D*. Amoeboid zoöspores of *O. Schenkiana* shortly after their emergence from the zoösporangium. *E*. Zoösporangium of *O. Schenkiana*. *F*. Young resting spore of *O. Schenkiana* with attached antheridium, showing penetration tube. *G*. Mature resting spore of *O. Schenkiana* with attached antheridium. *H*. Cells of *O. Schenkiana* containing young, single, bilobed thalli of *Ectrogella Besseyi*. *I*. Parasitized cell of *O. Schenkiana* showing incompletely formed discharge tube. Zoöspores of *E. Besseyi* have escaped through tube located on underside. *J*. Similar to figure 9. A portion of cytoplasm is left in one lobe of the *Ectrogella* thallus after discharge of zoöspores. *K*. Four thalli of *E. Besseyi* parasitizing one *O. Schenkiana* thallus. The unopened discharge tube is that of the *Olpidiopsis*. *L*. Formation of discharge tubes of *E. Besseyi*. Encysted zoöspores and secondary zoöspore above are from another thallus. *M*. Formation of multiple discharge tubes and discharge of zoöspores by *E. Besseyi*. Zoöspores encyst at the mouth as in *Achlya*. Incompletely formed discharge tube at lower right is that of the host, *O. Schenkiana*.

KEYS TO THE ORDERS, FAMILIES, AND GENERA OF THE GASTEROMYCETES [1]

S. M. Zeller *

These keys are presented with no claim for originality. They have been prepared with full use of published keys, helpful literature, and personal advice from colleagues. Undoubtedly the most helpful have been the publications of our late colleague, Dr. Ed. Fischer, especially his most recent monograph (**1933**). Others whose assistance and advice have been sought and are thankfully acknowledged are Dr. W. C. Coker, Dr. H. M. Fitzpatrick, Dr. W. H. Long, Dr. G. W. Martin, and Dr. D. P. Rogers. Publications by the following authors have been used for ready reference: Bataille (**1923**), Coker & Couch (**1928**), Cunningham (**1942**), Fischer (**1933**), Hollós (**1904**), Kambly & Lee (**1936**), Lohman (**1927**), Lohwag (**1926**), Long (**1907**), (**1917**), (**1940**), (**1941** [*2*]), (**1942** [*2*]), (**1943** [*3*]), (**1944**), (**1945**), and (**1946** [*3*]), Longnecker (**1927**), Malençon (**1931**), Martin (**1936**), (**1941**), Morgan (**1889–1893**), Pilat (**1934**), Rea (**1942**), Stevenson and Cash (**1936**), and White (**1901**), (**1902**).

The following keys include all of the genera considered acceptable by the author. Genera which have been reduced to synonymy or may be considered doubtful are not mentioned here. Some of them have been dealt with elsewhere [2] or will be given consideration later when certain of the genera will be treated specifically. The new orders, Gautieriales and Tremellogastrales, have been previously discussed.[2]

[1] Published as Technical Paper No. 536, with the approval of the Director of the Oregon Agricultural Experiment Station. Contribution from the Department of Botany of Oregon State College and The New York Botanical Garden, Cryptogamic Herbarium, co-operating.

* Dr. Zeller died Nov. 4, 1948.

[2] Zeller, S. M. Notes on certain Gasteromycetes, including two new orders. Mycologia **40**: 639–668. 1948.

It is realized there are several ways to build keys. One method is to follow strictly along lines of phylogeny, while another is merely an implement of plant identification. The keys presented below are primarily for plant identification without particular emphasis on relationships, although both methods are employed. For that reason, factors that may be used to separate two families or genera may not be the outstanding character or characters of the unit, but merely a sure way to distinguish them.

It will be helpful if colleagues will offer criticism on the keys as a whole or in part and on the general plan of organization of the Gasteromycetes as presented here.

KEY TO ORDERS OF THE GASTEROMYCETES

I. Gleba or spore mass surrounded by, or extending out to, a peridium at maturity (rarely without peridium), with one to many cavities, or lacunae filled with gel or basidia-bearing hyphae or nests.
  A. Original structure of gleba maintained until maturity, mostly bulb-like, hypogeous (sometimes epigeous), rarely stalked.
    1. Gleba more or less fleshy, not cartilaginous; basidia in a true hymenium (except in *Melanogastraceae*) ....1. *Hymenogastrales*
    2. Gleba and/or peridium cartilaginous or gelatinous or both.
      a. Spores ellipsoid, fusoid; with longitudinal ribs (costate). 2. *Gautieriales*
      b. Spores spherical, ellipsoid, ovoid, echinulate or sculptured. 3. *Tremellogastrales*
      c. Spores bacillar, ellipsoid, smooth; basidia phalloid. 4. *Hysterangiales*
  B. Gleba disorganized or fallen apart at maturity; peridium usually opening at maturity.
    1. Gleba a powdery or pulpy spore mass at maturity (except *Arachniaceae*).
      a. Gleba chambered by the outgrowth of tramal plates or pegs, walls of chambers covered with at least a rudimentary hymenium of basidia.
        1′. Gleba interspersed with or surrounded by a pseudoparenchymatous, spongy receptacle, which finally through its extension elevates the gleba, or holds it on the inner wall of a hollow chamber; spore mass pulpy, usually slimy and odoriferous, without capillitium .....5. *Phallales*
        2′. Gleba without receptacle; spore mass powdery at maturity (except *Arachniaceae*), with some sort of capillitium.
          a′. Peridium with one or more gelatinous layers. 3. *Tremellogastrales*
          b′. Peridium without gelatinous layer .....6. *Lycoperdales*

b. Gleba with symmetrically distributed basidia, or with basidia-bearing nests or lacunae arising through the dissolution of fundamental tissue, without a well organized hymenium (except *Batarrea*) .....7. *Sclerodermatales*

2. Glebal cavities isolated from one another as hard or brittle peridioles or "egg-like" bodies, through the dissolution of the tissue lying between; peridioles adhering to the inside of the peridium or forcibly ejected .....8. *Nidulariales*

II. Gleba or spore mass until maturity on the under or inner side of a centrally stalked cap or peridium; basidia at first in a true hymenium. 9. *Podaxales*

ORDER I—HYMENOGASTRALES

Fructifications *mostly* hypogeous, bulblike, occasionally pear- or spindle-shaped, stalked, or epigeous; rarely with a stemlike columella; peridium remaining indehiscent to maturity, seldom disintegrating early; gleba of one or more cavities, lacunae filled with gel or with basidia-bearing hyphae or nests, holding original structure to maturity; peridium and gleba essentially fleshy, not cartilaginous; conidiophores when present borne in hymenium with basidia (*Holocotylon*) or in a separate fructification (*Leucophleps*, conidial stage of *Leucogaster*).

KEY TO FAMILIES IN THE HYMENOGASTRALES

I. Fructification minute, with a single glebal cavity at maturity.
  A. Spores smooth (coralloid development of fructification). Family 1. *Protogasteraceae*
  B. Spores verrucose (campanulate development of fructification). Family 2. *Gasterellaceae*

II. Fructification with many cavities, or basidial nests, or gel-filled cavities.
  A. Gleba with basidial nests or gel-filled cavities, or cavities lined with a false or rudimentary hymenium .....Family 3. *Melanogasteraceae*
  B. Gleba with open cavities lined with a true hymenium.
    1. Spores smooth .....Family 4. *Rhizopogonaceae*
    2. Spores verrucose .....Family 5. *Hymenogasteraceae*
    3. Spores echinulate .....Family 6. *Hydnangiaceae*

PROTOGASTERACEAE

Fructifications subspherical, hypogeous, very small, uniloculate, coralloid development; cavities lined with a basidial hymenium; spores smooth.

One genus, *Protogaster*.

GASTERELLACEAE

Fructifications very small, depressed globose, epigeous, campanulate development; gleba finally uniloculate, but at times with one circle of cavities formed by vertical, centripetal invaginations which reach the center forming a false columella; cavities lined with a basidial hymenium; spores verrucose, dark.

KEY TO THE GENERA OF THE GASTERELLACEAE

I. Gleba at first and at maturity consisting of a single, hymenium-lined cavity ..... 1. *Gasterella*

II. Gleba at first with a percurrent columella around which is one circle of cavities formed by vertical, centripetal invaginations which reach the center forming a false columella, and break away again at maturity; finally uniloculate ..... 2. *Gasterellopsis*

MELANOGASTERACEAE

Fructifications subglobose, usually hypogeous, sometimes stipitate at maturity; gleba of lacunae with basidia in nests or in a rudimentary hymenium from the walls of jelly-filled or pseudoparenchyma-stuffed cavities; gleba not becoming powdery; capillitium none.

KEY TO THE GENERA OF THE MELANOGASTERACEAE

I. Gleba black or brown with basidia scattered through gel-filled lacunae.
  A. Gleba black marbled with whitish veins ..... *Melanogaster*
  B. Gleba dark brown, marbled with light brown veins.
    1. Spores ellipsoid, smooth ..... *Alpova*
    2. Spores spherical, echinulate; peridium and septa with lactiferous ducts ..... *Maccagnia* (Not known in North America)
    3. Spores citriform, rough with loose epispore, as in *Hymenogaster*. *Chondrogaster* (Not known in North America)

II. Gleba light colored to white.
  A. Fructifications not stipitate.
    1. Gleba lacunate, not chambered, hard. *Corditubera* (Not known in North America)
    2. Gleba chambered, with an irregular hymenium lining chambers filled with hyphal tissue or gel.
      a. Spores borne on basidia.
        1′. Spores ellipsoid, smooth, without a gelatinous sheath. *Cremeogaster*
        2′. Spores mostly spherical, pitted, covered by a gelatinous sheath ..... *Leucogaster*
      b. Spores borne on conidiophores ..... *Leucophleps*

B. Fructification stipitate; volvate stem; spores oblong, hyaline.
Torrendia (Not known in North America)

RHIZOPOGONACEAE

Fructifications subglobose, hypogeous or epigeous; peridium simple, with or without rhizomorphic fibrils over the surface; gleba fleshy, not cartilaginous, with open irregularly arranged cavities, or cavities diverging from the base or from a branched or simple columella; original structure of gleba maintained to maturity; basidia in true hymenia; spores smooth, tinted.

KEY TO THE GENERA OF THE RHIZOPOGONACEAE

I. Fructifications mostly hypogeous, with rhizomorphic fibrils over the surface of the peridium, hymenium of basidia and paraphyses.
A. Gleba without columella or conspicuous dendroid tramal plates.
Rhizopogon
B. Gleba with columella or conspicuous dendroid tramal plates.
Truncocolumella
II. Fructifications epigeous, with no superficial fibrils, hymenium of basidia, conidiophores, and paraphyses ..... *Holocotylon*
III. Fructifications with hollow stems, epigeous; spores ellipsoid, smooth.
Le Ratia (Not known in North America)

HYMENOGASTERACEAE

Fructifications globose, hypogeous, with or without rhizomorphic fibrils over the surface of the peridium; peridium simple; gleba fleshy, not cartilaginous, dark, with or without columella; with true basidial hymenium; spores dark, verrucose.

KEY TO THE GENERA OF THE HYMENOGASTERACEAE

I. Fructifications without columella.
A. Spores verrucose, mostly citriform ..... *Hymenogaster*
B. Spores angular, as in *Leptonia* * ..... *Richoniella*
II. Fructifications with dendroid or percurrent columella, spores verrucose, mostly citriform ..... *Gymnoglossum*

HYDNANGIACEAE

Fructifications hypogeous, subglobose or subpileate; with or without a columella or stipe, with campanulate development;

* Editor's note: This genus of the Agaricaceae is included in *Rhodophyllus* by most modern authors.

gleba fleshy, not cartilaginous, maintaining original structure to maturity; with true basidial hymenium; sometimes with lactiferous ducts; spores echinulate, slightly tinted, usually spherical.

KEY TO THE GENERA OF HYDNANGIACEAE

I. Gleba without columella, or tissues without lactiferous ducts; spores subglobose.
  A. Spores thick-walled; gleba gelatinous, cavities filled with spores. *Sclerogaster*
  B. Spores with thinner walls; gleba fleshy, not gelatinous. . *Hydnangium*
II. Gleba with columella, and with lactiferous ducts in some or all tissues ..... *Arcangeliella*
III. Gleba with columella or stipe; tissues without lactiferous ducts but always with islands of pseudoparenchyma ..... *Elasmomyces*

ORDER II—GAUTIERIALES

Fructifications hypogeous, sessile; peridium wanting or present, when present stupose, loosely filamentous or pseudoparenchymatous; gleba gristly translucent and white when fresh, becoming brittle and brownish as spores mature; columella from a basal rhizomorph; basidia in a hymenium; septa usually gelatinous-cartilaginous, of gelified hyphae; basidiospores of various shapes, mostly broad fusiform, verrucose or longitudinally costate, brown.

One family, *7. Gautieriaceae,* with characters of the order. There is one genus, *Gautieria.*

ORDER III—TREMELLOGASTRALES

Fructifications hypogeous or epigeous, mostly sessile; peridium of two or more layers, the outer of fundamental tissue, the inner of a gelatinous nature, continuous or interrupted by sutures of fundamental tissue; gleba centripetally developed, pulverulent at maturity; columella simple or wanting; spores spherical, echinulate, verrucose or cristate.

KEY TO THE FAMILIES OF THE ORDER TREMELLOGASTRALES

I. Peridium with a gelatinous inner layer interrupted by sutures of fundamental tissue; spores spherical, echinulate or cristate. Family 8. *Tremellogasteraceae*
II. Peridium with a simple, continuous gelatinous inner layer; spores spherical, minutely verrucose ..... Family 9. *Gastrosporiaceae*

TREMELLOGASTERACEAE

Fructifications hypogeous or epigeous, mostly sessile; peridium of two or more layers, the outer of fundamental tissue, the inner of a gelatinous nature, interrupted by sutures of fundamental tissue; gleba centripetally developed, pulverulent at maturity; spores spherical, echinulate or cristate.

KEY TO THE GENERA OF THE TREMELLOGASTERACEAE

I. Inner layer of the peridium very thick, with branched sutures of fundamental tissue dividing the gelatinous portion of the inner peridium radially and periclinally into two more or less definite layers; spores spherical, echinulate ...*Tremellogaster* (Not known in North America)
II. Inner layer of the peridium thinner, of one gelatinous layer interrupted by radial sutures of fundamental tissue; spores spherical, echinulate and cristate or cristate only ..*Clathrogaster* (Not known in North America)

GASTROSPORIACEAE

Fructifications hypogeous, subglobose, from a single rhizomorph; peridium duplex, outer layer thin, of fundamental tissue (fibrous); inner layer gelatinous, continuous; columella simple; gleba pulverulent or deliquescent at maturity; spores spherical, minutely verrucose, slightly tinted or nearly hyaline.

One genus, *Gastrosporium*, not found in North America.

ORDER IV—HYSTERANGIALES

Fructifications mostly hypogeous, globose or elongate, mostly from rhizomorphic strands; peridium simple or with 2 to 3 layers, or with an inner gelatinous layer (tramal peridium); gleba cartilaginous, gelatinous; basidia phalloid; spores smooth, ellipsoid to bacillar; tramal structure radiating from the base or as continuations from the mycelial strands, diverging from sterile base, or from gelatinous or cartilaginous columella. Rarely with a percurrent columella (*Rhopalogaster*).

KEY TO FAMILIES IN THE HYSTERANGIALES

I. Tramal peridium not continuous.
  A. Tramal peridium not well developed or if so, cartilaginous, thin, interrupted by fertile or infertile cavities which are usually not filled by peridial tissue .....Family 10. *Hysterangiaceae*

B. Tramal peridium thick, gelatinous, interrupted by thin plates (sutures) of peridial tissue having unbroken connection with the fundamental peridium and sectors of the gleba..Family 11. *Protophallaceae*

II. Tramal peridium continuous, thick, gelatinous..Family 12. *Gelopellaceae*

HYSTERANGIACEAE

Fructifications hypogeous, mostly with rhizomorphic strands or heavy mycelial spawn; peridium simple or with 2 or 3 layers; gleba cartilaginous, gelatinous, tramal structure radiating from the base or from a gelatinous columella (columella percurrent in *Rhopalogaster*); spores smooth, ellipsoid, or bacillar.

KEY TO GENERA OF THE HYSTERANGIACEAE

I. Fructifications with prolonged, tapering, stalk-like sterile base, or extended into a branched, but not percurrent, columella.

A. Thicker branches of the columella not dividing the gleba into sharply delimited sectors.

1. Fructifications not stalked .....*Hysterangium*

2. Fructifications with short stalk, extending into the gleba as a hemispherical, sterile base .....*Jaczewskia*

B. Thicker branches of the columella dividing the gleba into sharply delimited sectors; fructifications with a prolonged, tapering, stem-like sterile base, pear-shaped .....*Phallogaster*

II. Fructifications with a stalk-like, unbranched percurrent columella. *Rhopalogaster*

PROTOPHALLACEAE

Fructifications subglobose, hypogeous or epigeous; peridium usually thin, of primary tissue covering a thick gelatinous tramal peridium which is interrupted by radial sutures having unbroken connection with the peridium and gleba, which is gelatinous or cartilaginous, olivaceous or brownish, usually sectored by gelatinous plates radiating from the base or from a columella; cavities empty then filled with spores; basidial hymenium lining cavities; spores small, bacillar, olivaceous.

KEY TO GENERA OF THE PROTOPHALLACEAE

I. Gleba a powdery mass at maturity .....*Calvarula*

II. Gleba gelatinous-cartilaginous at maturity .....*Protubera*

GELOPELLACEAE

Fructifications subglobose, hypogeous; peridium thin, filamentous, surrounding a thick, continuous, gelatinous layer (tramal peridium); gleba dark, cartilaginous or gelatinous; cavities lined with basidial hymenium; columella simple or branched (pendant in *G. hahashimensis*); spores small, smooth, colored.

One genus, *Gelopellis*, not known in North America.

ORDER V—PHALLALES

Fructifications at first with a gelatinous universal veil, which is left at maturity as a cupulate volva at the base of a subspherical or ovoid, or a latticed or stem-like, pseudoparenchymatous receptacle which may be with or without a cap; gleba usually mucilaginous at maturity, surrounded by the receptacle, lying between its branches, or on the exterior of the cap or on the modified upper portion of the stem; spores bacillar, smooth.

KEY TO THE FAMILIES OF THE PHALLALES

I. Receptacle simple, hollow, ovoid .....Family 13. *Claustulaceae*
II. Receptacle stalk-like, hollow, cylindrical or fusiform, with or without a bell-shaped cap; gleba borne on exterior of cap or on the outside of a modified upper portion of the stem .....Family 14. *Phallaceae*
III. Receptacle latticed, lobed, or with irregular branches, stalked or stalkless; gleba surrounded by the receptacle or lying between its arms. Family 15. *Clathraceae*

CLAUSTULACEAE

Fructifications spherical, smooth; peridium of 2 layers, the outer rind thin, of filamentous tissue, inner layer gelatinous, continuous; receptacle a hollow, indehiscent, pseudoparenchymatous sphere; gleba lining the interior of the receptacle, confined to one layer of cells; spores smooth, ellipsoid.

One genus, *Claustula*, not known in North America.

PHALLACEAE

Volva cupulate or sheathing, of 2 layers, the outer thin rind of filamentous primary tissue, the inner a thick, continuous, gelatinous layer; gleba surrounding the upper part of the receptacle;

receptacle porous, stalk-like, with or without a bell-shaped cap and sometimes with a continuous or meshy indusium; spores olivaceous or greenish, smooth, small, bacillar.

KEY TO THE GENERA OF THE PHALLACEAE

I. Receptacle simple, stalk-like, without a freely hanging campanulate cap, upper part wholly covered by a spore mass (gleba) or covered in a girdling zone only.
  A. Gleba-covered part of the receptacle without a pseudoparenchymatous sheath or reticulum.
    1. Receptacle in young stages not percurrent in the volva; fructifications growing on wood.
      Xylophallus (Not known in North America)
    2. Receptacle in young stages percurrent in the volva; fructifications growing on the ground; buttons hypogeous.
      a. Gleba covering a ring-like zone on the receptacle, below a sterile tip ..... *Stahelíomyces*
      b. Gleba covering most of the upper part (head) of the receptacle ..... *Mutinus*
  B. Glebal part of the receptacle covered by the pseudoparenchymatous sheath or reticulum.
    1. Sheath closely fitting, smooth, granulose, papillose or netted.
      Jansia (Not known in North America)
    2. Glebal part of the receptacle covered by a loosely fitting pseudoparenchymatous reticulum.
      Floccomutinus (Not known in North America)

II. Receptacle composed of a hollow stem and a campanulate cap upon the outer surface of which the mass of spores (gleba) is borne.
  A. Indusium or reticulum not present at maturity.
    1. Cap and gleba continuous over the apex of the receptacle; cap gelatinous, fastened at lower edge to the stem.
      Aporophallus (Not known in North America)
    2. Apex of the receptacle covered by a pseudoparenchymatous cap or disk; gleba throughout pierced by numerous pseudoparenchymatous plates or strands, extending from the upper end of the stem or cap ..... *Itajahya*
    3. Apex of the receptacle with an uncovered pore into the hollow of the receptacle, edge of the cap free; gleba not pierced by plates to the upper surface, but underlaid by a meshiness over the cap.
      Phallus
  B. Stem of the receptacle with a pseudoparenchymatous reticulum (indusium) hanging from under the cap.
    1. Reticulum (indusium) very short, collar-like, hidden under the cap; the latter perforated, lattice-like.
      Echinophallus (Not known in North America)
    2. Indusium at maturity longer than the cap, mostly net-like; cap not perforated ..... *Dictyophora*

CLATHRACEAE

Volva at first enclosing the whole fructification, of 2 layers, the outer a thin filamentous layer, the inner a thick gelatinous layer (tramal peridium) interrupted by thin plates or sutures of primary, filamentous tissue making connection with the outer layer of the volva and sectors of the gleba; receptacle latticed, or with coral-like ramifications, stalked or sessile; gleba surrounded by portions of the receptacle or lying between its branches, dark olivaceous; spores small, bacillar, smooth.

KEY TO THE GENERA OF THE CLATHRACEAE

Receptacle latticed or as meridian-like branches over the apex, branches fastened or with free ends at apex, like spokes of a wheel or like the upward rays on a crown; stalked or sessile.

A. Branches of receptacle solid, thick, composed of many layers of chambers.

1. Receptacle sessile, branches bound together lattice- or net-like. *Clathrus*

2. Receptacle sessile, with meridian-like branches bound together at apex only.

a. Walls of the innermost chamber of receptacle branches not opening at maturity ..... *Colonnaria*

b. Walls of innermost chamber of receptacle branches finally parting as wing-like appendages. *Blumenavia* (Not known in North America)

3. Receptacle stalked, with arms free at apex. *Aseroë* (Not known in North America)

B. Branches of receptacle slender, terete, stalked, or bandlike, a single tube, or composed of very few layers of chambers.

1. Receptacle with branches bound together lattice-like.

a. Receptacle long stalked; the latticed upper part hemispherical to spheroid, with small meshes ..... *Simblum*

b. Receptacle tapering downward, sessile or short stalked; lower meshes narrow, strongly elongated vertically, upper isodiametric, very small ..... *Colus* (Not known in North America)

2. Receptacle with only vertical branches bound together at the apex.

a. Receptacle sessile ..... *Laternea*

b. Receptacle stalked ..... *Pseudocolus*

3. Upper end of receptacle with extended arms.

a. Branches of the receptacle coming off vertically from the wall of the stem ..... *Lysurus*

b. Receptacle branches arising from the edge of a seam or an orbicular extension of the upper end of the stem and spreading horizontally at maturity. *Aseroë* (Not known in North America)

II. Receptacle stalked, beset by irregular coral-like processes extending radially from the upper end and between which the spore masses (gleba) lie .....*Kalchbrennera* (Not known in North America)

ORDER VI—LYCOPERDALES

Fructifications mostly epigeous, sessile, single or in groups on a stromatic layer, rarely substipitate, globose, pyriform, etc.; peridium 2–4-layered, dehiscing by an apical pore, by several pores, by irregular or stellate cleavages, or crumbling at maturity; gleba wholly fertile or sterile below, becoming a powdery mass or chambers breaking apart and forming at maturity small hollow peridioles; basidia borne in a hymenium; capillitium present (except in *Arachniaceae*).

KEY TO THE FAMILIES OF THE LYCOPERDALES

I. Whole peridium brittle, disintegrating at maturity; glebal chambers remaining intact but their walls scissile allowing the chambers to fall apart as peridioles, as fine sand-like particles .....Family 16. *Arachniaceae*

II. Endoperidium persistent; glebal chambers disintegrating into a powdery mass at maturity.

A. Exoperidium not opening stellately at maturity (*Mycenastrum* possible exception).

1. Peridium 2-layered, dehiscing by an apical stoma or breaking irregularly.

a. Threads of capillitium smooth, branched, with or without a conspicuous, thick, main filament.

1′. Fructifications not on a stroma ..Family 17. *Lycoperdaceae*

2′. Fructifications singly or many on a stroma.
Family 18. *Broomeiaceae*

b. Threads of capillitium with small, short, pointed (spine-like) side branches .....Family 19. *Mycenastraceae*

2. Peridium 2–3-layered, indehiscent or rupturing irregularly at apex; capillitium unbranched .....Family 20. *Mesophelliaceae*

B. Exoperidium opening stellately at maturity.
Family 21. *Geastraceae*

ARACHNIACEAE

Fructifications epigeous, small; peridium thin, fragile, breaking irregularly or crumbling at maturity to liberate the peridioles; gleba made up of numerous spherical chambers lined with a hymenium, forming at maturity a mass of minute, separate peridioles which are like grains of sand; capillitium and sterile base none; spores smooth.

KEY TO GENERA IN THE ARACHNIACEAE

I. Fructifications sessile, columella wanting ..... *Arachnion*
II. Fructifications stipitate, columella present ..... *Arancosa*

LYCOPERDACEAE

Fructifications single or in groups, mostly epigeous, subglobose to pyriform or nearly stipitate; gleba wholly fertile, or sterile below; outer peridium mostly a layer of pseudoparenchyma, rarely with a rind that is skin-like or permeated with soil particles, wholly or partially disintegrating at maturity, laying the inner peridium bare; inner peridium usually papery and thin, rarely corky and thick, usually dehiscing by an apical pore; rarely (in *Lycoperdopsis*) the two layers adhere to each other forming a simple pseudoparenchymatous rind, usually opening by an apical pore; capillitium well developed, sometimes falling into pieces.

KEY TO GENERA IN THE LYCOPERDACEAE

I. Peridium of a loosely interwoven endoperidium and closely adhering pseudoparenchymatous exoperidium.
Lycoperdopsis (Not known in North America)
II. Peridium with a sharply differentiated, thicker textured endoperidium which is laid bare at maturity by sloughing the exoperidium.
A. Endoperidium dehiscing by an apical pore (sometimes basal in *Disciseda*).
1. Threads of capillitium smooth, more or less symmetrical, without a conspicuous main stem.
a. Exoperidium wholly disintegrating.
1'. Capillitium accompanied by membranes at maturity.
Morgancella
2'. Capillitium not accompanied by membranes at maturity.
Lycoperdon
b. Exoperidium like a rind, or skin-like, or permeated with soil particles, and finally separating (circumscissilely) from a discoid or scutellate base exposing the endoperidium .... *Disciseda*
2. Threads of capillitium very much branched, with a conspicuous main stem and slender branches with tapering pointed ends; spores with long pedicels ..... *Bovistella*
B. Endoperidium without apical pore, dehiscing by irregular rupture.
1. Threads of capillitium smooth, without conspicuous main stem or conspicuous branching.
a. Capillitium smooth or granular, broken, leaving blunt ends, sparingly branched.

1'. Endoperidium breaking up and falling away, usually leaving a sterile base covered by a definite membrane; capillitium threads usually broken ..... *Calvatia*

2'. Endoperidium cartilaginous, very thin above, splitting into several irregular tooth-like segments at apex .. *Arachniopsis*

b. Capillitium threads simple, smooth, short with sharp ends. *Bovistoides* (Not known in North America)

2. Threads of capillitium much branched with main stem and branches with long tapering pointed ends; free, not attached.

a. Capillitium threads not thickly interwoven, dispersing readily when exposed ..... *Bovista*

b. Capillitium threads densely interwoven into balls ..... *Lanopila*

BROOMEIACEAE

Fructifications singly or many on a stroma, mostly ovoid, hemispheric, or subglobose; exoperidium thin, wholly or partly disintegrated at maturity, endoperidium papery or thickish, laid bare at maturity, opening by an apical pore; capillitium present, threads more or less symmetrical, without a conspicuous, thick, main filament.

KEY TO THE GENERA OF THE BROOMEIACEAE

I. Fructifications more or less singly on a stroma, somewhat hemispheric ..... *Lycogalopsis*

II. Fructifications many on a stroma, mostly ovoid.

A. Stroma thick, stalked, or columnar. *Broomeia* (Not known in North America)

B. Stroma sessile, resupinate, or patellate ..... *Diplocystis*

MYCENASTRACEAE

Fructifications large, subglobose to depressed globose; peridium duplex, exoperidium thick, spongy, smooth or areolate, endoperidium thick and leathery, or thin and membranaceous; capillitium branched with short pointed spines; spores spherical to ellipsoid, verrucose.

KEY TO THE GENERA OF THE MYCENASTRACEAE

I. Outer peridium smooth, thick, spongy, drying thin, fragile; inner peridium thick, corky, splitting stellately at maturity ..... *Mycenastrum*

II. Outer peridium thick, coriaceous, areolate with irregular pyramidal sections; inner peridium thin ..... *Calbovista*

MESOPHELLIACEAE

Fructifications hypogeous or epigeous, singly or several in a stroma; peridium usually 2–3-layered, indehiscent or rupturing irregularly at the apex; capillitium unbranched; spores globose or ellipsoid, variously roughened or with a gelatinous sheath.

KEY TO THE GENERA IN THE MESOPHELLIACEAE

I. Spores globose, echinulate, reticulate, or verrucose.
  A. Gleba with a sterile base ..... *Radiigera*
  B. Gleba without a sterile base.
    a. Endoperidium without apical dehiscence ..... *Abstoma*
    b. Endoperidium dehiscing by a simple stoma or lacerated opening ..... *Bovistina*

II. Spores ellipsoid, smooth or irregularly roughened.
  A. Gleba with a large, hard, central core.
    Mesophellia (Not known in North America)
  B. Gleba without a central core.
    Castorcum (Not known in North America)

GEASTRACEAE

Fructifications at first hypogeous, or epigeous from the first, rounded or stalk-like below; peridium duplex; outer peridium 2–3-layered, pseudoparenchymatous layer within surrounded by a fibrous layer, at maturity opening out stellately (in *Trichaster* the inner and outer peridium opening together); inner peridium papery thin, loosening from the outer peridium and dehiscing by a pore, or irregularly, or by many pores; gleba with a sterile columella from which the tubular chambers radiate.

KEY TO THE GENERA IN THE GEASTRACEAE

I. Endoperidium exposed as a whole at maturity, opening by a single, or rarely several pores.
  A. Endoperidium sessile or on a short stalk ..... *Geastrum*
  B. Endoperidium on several thin stalks, with several pores above.
    Myriostoma

II. Endoperidium disintegrating at maturity.
  A. Endoperidium with a prominent sterile base; columella soft, weak.
    Geasteroides Long (Not *Geastroides* Battarra)
  B. Endoperidium and exoperidium remaining joined and opening stellately together; without a sterile base; columella hard, sub-woody.
    Trichaster (Not known in North America)

ORDER VII—SCLERODERMATALES

Fructifications mostly epigeous; sporocarp sessile, on a false stem, or if stipitate, borne entirely above the stem or its expanded summit; peridium of 1–4 layers, dehiscing by an apical stoma, or by irregular fissuring or circumscissilely; gleba pulverulent at maturity, with or without capillitium; basidia symmetrically distributed or in nests or cavities arising through the dissolution of the tissue, without a well organized hymenium (except possibly in *Batarrea*).

KEY TO THE FAMILIES OF THE SCLERODERMATALES

I. Peridium mostly simple.
  A. Capillitium wanting or rudimentary.
    1. Gleba mostly veined or lacunate, developing internally or centrifugally .....Family 22. *Sclerodermataceae*
    2. Gleba with veins definitely extending centripetally from the peridium .....Family 23. *Sedeculaceae*
    3. Gleba breaking up into small peridioles..Family 24. *Pisolithaceae*
  B. Capillitium well developed; gleba entirely homogeneous.
    Family 25. *Glischrodermataceae*

II. Peridium with distinct exo- and endoperidium.
  A. Sporocarp with a distinct, firm or gelatinous stalk; endoperidium persistent, papery, breaking away from the exoperidium at maturity.
    1. Stalk firm, fibrous or woody .....Family 26. *Tulostomataceae*
    2. Stalk made up of anastomosed strands forming a rough, lacunose stem, usually quite gelatinous when fresh.
    Family 27. *Calostomataceae*
  B. Sporocarp sessile; exoperidium thick, splitting more or less readily from the endoperidium, so as to form astral rays.
    Family 28. *Astraeaceae*

SCLERODERMATACEAE

Fructifications mostly epigeous, rarely hypogeous or emergent, subglobose, sessile or with an irregular root-like stem; peridium mostly simple, rarely 2-layered, firm, rarely thin, membranous, breaking open irregularly or in lobes or decaying; gleba with sharply defined basidia-bearing sectors, which are partitioned from one another by sterile veins, and in which the basidia are regularly scattered through the tissue (rarely, if ever, with hymenium-lined cavities or with fascicled, nested basidia); basidia broadly club-shaped; gleba crumbling to a powder of spores and disintegrating tissues at maturity; spores usually sculptured; capillitium wanting, or rudimentary.

KEY TO THE GENERA OF THE SCLERODERMATACEAE

A. Fructifications sessile or with elongate root-like base.
  1. Peridium smooth, finely warted or coarse surface.
    a. Spores without a distinct hilum or pedicel .....*Scleroderma*
    b. Spores with a hilum or pedicellate .....*Pompholyx*
  2. Peridium spiny or coarsely pyramidally warted.
    Caloderma (Not known in North America)
B. Fructifications with slender stem.
  Pirogaster (Not known in North America)

SEDECULACEAE

Fructifications leathery, without sterile base or radicle; peridium thick, leathery above, almost obsolete and dehiscing below; gleba becoming powdery at maturity, with broad veins extending inward from the peridium; spores brown, pedicellate or with sterigmatal scar.

One genus, *Sedecula*.

PISOLITHACEAE

Fructifications mostly stalked, rarely sessile (in *Pisolithus*); stems root-like or hard and wood-like; sporocarps subglobose, pear-shaped, or hemispherical; peridium thin or layers not separating readily, breaking away irregularly; gleba dark, made up of roundish or irregular basidia-bearing sectors or peridioles which loosen and break away at maturity; capillitium none; spores colored, sculptured.

KEY TO THE GENERA OF THE PISOLITHACEAE

I. Sporocarp sessile or with a rootlike stalk; peridium thin ....*Pisolithus*
II. Sporocarp with a hard woodlike stalk; peridium thick, hard.
  Dictyocephalos

GLISCHRODERMATACEAE

Fructifications subglobose, on a superficial mycelium; peridium simple, thin but hard and tough, opening by an apical pore; gleba with evenly distributed basidia (without sterile veins), capillitium arising from the inner side of the peridium (as in *Calvatia*); spores sculptured.

One genus, *Glischroderma*, found in Europe only.

TULOSTOMATACEAE

Fructifications at first hypogeous, sporocarp elevated by the prolongation of a basal tissue into a stout, fibrous, stemlike or cushionlike process; peridium duplex, outer layer partly evanescent, partly remaining as a cuplike volva at the base of the stem, inner layer thin, dehiscing by an apical pore, several pores or circumscissilely; gleba without chambers or chambered by the labyrinthine separation of the tissues from one another; basidia regularly and evenly distributed in the glebal tissue or forming a rudimentary hymenium on the walls of chambers; capillitium well-developed, attached to the inside of the peridium; spores variously sculptured.

KEY TO THE GENERA OF THE TULOSTOMATACEAE

I. Basidia borne irregularly in fascicles or nests; endoperidium dehiscing irregularly or through a stoma.
  A. Stem more or less readily breaking from the sporocarp, as out of a socket.
    1. Sporocarp dehiscing by an apical stoma ..... *Tulostoma*
    2. Sporocarp dehiscing by a roughly stellate stoma .... *Schizostoma*
    3. Sporocarp dehiscing irregularly ..... *Queletia*
  B. Exoperidium continuous with the outer layer of the stem, endoperidium forming more or less of a cup or collar on the margin of the expanded apex of the stem; stem not volvate ..... *Phellorinia*
  C. Exoperidium not continuous with the stem, sporocarp seated on the expanded apex of the stem; stem volvate ..... *Chlamydopus*
II. Basidia borne in an elementary hymenium lining cavities; endoperidium dehiscence circumscissile or through numerous pores ..... *Battarrea*

ASTRAEACEAE

Fructifications epigeous or at first hypogeous, sessile; peridium of several layers, the outer two or three becoming the very heavy exoperidium, which dehisces stellately; the endoperidium thin, membranous; columella none; gleba separated by delicate sterile veins into basidia-bearing sectors in which the basidia are regularly distributed throughout the context; basidia broadly clubshaped; spores spherical, sculptured; capillitium none.

One genus. *Astraeus*.

CALOSTOMATACEAE

Fructifications epigeous or at first hypogeous, stalked with a root-like, lacunose basal process; peridium duplex, exoperidium

cartilaginous, extended below into a rootlike stalk and often cupulate around the base of the sporocarp; endoperidium cartilaginous, with an ornate apical stellate stoma below which the spore sac is suspended; gleba pulverulent; spores spherical or ellipsoid, smooth or sculptured.

One genus, *Calostoma*.

ORDER VIII—NIDULARIALES

Fructifications small, sessile, cupulate, campanulate or depressed globose; peridium of one to four layers, dehiscing by rupture of an epiphragm or lid over the top, or when this is absent, by irregular fissuring of the wall; gleba enclosed in one or many globose or lens-shaped peridioles; peridioles attached to the inner wall of the peridium by a mucilaginous secretion or by threadlike funiculi, escaping singly or they may be forcibly ejected from the exoperidium; capillitium none.

KEY TO THE FAMILIES OF THE NIDULARIALES

I. Exoperidium more or less urceolate and firm at maturity; glebal chambers (peridioles) egglike, remaining attached or free within outer peridium, empty ..... Family 29. *Nidulariaceae*

II. Exoperidium collapsed at maturity; single spherical, glebal chamber violently discharged at maturity, filled with gel or gelatinous tissue. Family 30. *Sphaerobolaceae*

NIDULARIACEAE

Fructifications epigeous, with hard peridium which opens cup-like at maturity; gleba with a few mostly flattish, rounded, closed chambers (peridioles), the hard walls of which are lined with basidial hymenium and in the mature fructification are isolated or freed from the cup-like fructification by ejection or by the deliquescence of the intervening tissue.

KEY TO THE GENERA OF THE NIDULARIACEAE

I. Peridioles without funiculus.
   A. Fructification roundish, without typical epiphragm ..... *Nidularia*
   B. Fructification beaker-shaped, with epiphragm ..... *Nidula*

II. Peridioles with funiculus; fructifications top-shaped, with epiphragm.
A. Peridium composed of three layers, middle layer of pseudoparenchyma; spores mixed with filaments .....*Cyathus*
B. Peridium composed of one layer, not pseudoparenchyma; spores not mixed with filaments .....*Crucibulum*

SPHAEROBOLACEAE

Fructifications tiny, spherical at first; peridium of several layers, of which the second inner layer is formed of turgescent cells appearing as a radial palisade; gleba of basidia-bearing sectors separated by sterile veins, or of basidia-bearing cavities formed by the splitting of tissues; the gleba becomes gelatinized at maturity and is ejected as a whole from the peridium.

KEY TO THE GENERA OF THE SPHAEROBOLACEAE

I. Basidia borne irregularly throughout the basidia-bearing sectors. *Sphaerobolus*
II. Basidia borne in hymenia on the walls of cavities .....*Nidulariopsis*

ORDER IX—PODAXALES

Fructifications epigeous, stalked or with percurrent columella, pileate at maturity, angiocarpic; stipe long or short, continued to the apex of the fructification as a columella; peridium simple or 2–3-layered at maturity, left at maturity in part as pileus, or volva, or annulus on the stem; gleba at first with hymenium of basidia covering the walls of chambers or pores or lamellae, persistent or pulverulent; capillitium wanting (except in *Podaxis*); spores colored.

KEY TO FAMILIES OF THE PODAXALES

I. Gleba not powdery at maturity .....Family 31. *Secotiaceae*
II. Gleba powdery at maturity .....Family 32. *Podaxaceae*

SECOTIACEAE

Fructifications mostly epigeous, stalked or sessile, at first campanulate, like an agaric button, angiocarpic; stalk continued above as a percurrent columella; peridium mostly as a cap covering the gleba, free at maturity or opening by a transverse slit; gleba chambered or with irregular pores or with anastomosing, lamel-

loid, tramal structures, dark brown to blackish, sometimes with cystidia, not becoming a powdery spore mass at maturity; spores dark, smooth or sculptured; capillitium none.

KEY TO THE GENERA OF THE SECOTIACEAE

I. Stems not volvate, not annulate; gleba brown.
  A. Fructifications short-stemmed or sessile; pileus mostly globose to depressed globose, spores smooth or sculptured .....*Secotium*
  B. Fructifications with long stems; pileus cylindrical to conic, slender, acute at apex; spores smooth .....*Galeropsis*
II. Stems volvate and/or annulate; spores black or very dark brown.
  A. Gleba lamelloid, radiating and hanging free from the margin of the expanded apex of the stem; stem volvate; spores black ..*Montagnea*
  B. Gleba of anastomosed lamellae, attached to the underside of the expanded top of the stem (pileus), free from the stem; stem annulate; spores black .....*Longula*
  C. Gleba of anastomosed to poroid lamellae, suspended from the lower surface of the pileus, free; stem with a cupulate or sheathing volva; annulus usually persistent; spores black (rusty black *in ours*). *Gyrophragmium*

PODAXACEAE

Fructifications angiocarpic, like agaric buttons, epigeous at maturity, clavate, ovoid or fusiform, stalked or almost sessile; stem firmly fibrous, extending percurrently as a columella; peridium pileate, simple or plicately scaly, brittle, easily splitting, margin loosening from the stipe at maturity or opening by longitudinal splitting; gleba at first chambered by anastomosing tramal tissues or lamelloid tramal plates, powdery at maturity; basidia persisting in *Podaxis;* capillitium well developed as elaters, or wanting; spores dark, smooth.

KEY TO THE GENERA OF THE PODAXACEAE

I. Fructification sessile or nearly so; gleba without capillitium. *Endoptychum*
II. Fructification with long stipe; gleba with capillitium (elaters) ..*Podaxis*

LITERATURE CITED

1. **Bataille, M. F.** Flore analytique et descriptive des Hyménogastracées d'Europe. Soc. Myc. France, Bul. **39**: 157–196. 1923.
2. **Coker, W. C., and J. N. Couch.** Gasteromycetes of the eastern United States and Canada. Univ. N. Carolina Press. Chapel Hill. Pp. 1–201. 1928.

3. **Cunningham, G. H.** The Gasteromycetes of Australia and New Zealand. John McIndoe, Printer, 76 Vogel St., Dunedin, New Zealand. Pp. 1–236. 1942.
4. **Fischer, Ed.** Gastromyceteae. In Engler & Prantl. Die Natürl. Pflanzenfam. (II ed.) **7a**: 1–122. 1933.
5. **Hollós, L.** Die Gasteromyceten Ungarns. Oswald Weigel, Leipzig. Pp. 1–278. *T. 1–29.* 1904.
6. **Kambly, P. E., and R. E. Lee.** The Gasteromycetes of Iowa. Univ. Iowa Studies Nat. Hist. **17** (No. 4): 117–185. 1936.
7. **Lloyd, C. G.** Mycological writings, Cincinnati, Ohio. **1–7**: *illus.* 1898–1925.
8. **Lohman, M. L.** The Iowa species of *Lycoperdon*. Univ. Iowa Studies Nat. Hist. **12** (No. 4): 5–28. *illus.* 1927.
9. **Lohwag, H.** Zur Entwiklungsgeschichte und Morphologie der Gasteromyceten. Beih. zum Bot. Centralbl. **42**: 177–334. *illus.* 1926.
10. **Long, W. H.** The Phalloideae of Texas. Jour. Myc. **13**: 102–114. *illus.* 1907.
11. ——. Notes on new or rare species of Gasteromycetes. Mycologia **9**: 271–274. 1917.
12. —— **and O. A. Plunkett.** Studies in the Gasteromycetes. I. The genus *Dictyocephalos*. Mycologia **32**: 696–709. 1940.
13. —— **and D. J. Stouffer.** II. *Boristina*, a new genus. Mycologia **33**: 270–273. 1941.
14. ——. III. The family Arachniaceae. Mycologia **33**: 350–355. 1941.
15. ——. IV. A new species of *Geaster*. Mycologia **34**: 13–16. 1942.
16. ——. V. A white *Simblum*. Mycologia **34**: 128–131. 1942.
17. —— **and D. J. Stouffer.** VII. The genus *Schizostoma*. Mycologia **35**: 21–32. 1943.
18. ——. VIII. *Battarrea laciniata*. Mycologia **35**: 546–556. 1943.
19. —— **and D. J. Stouffer.** IX. The genus *Itajahya* in North America. Mycologia **35**: 620–628. 1943.
20. ——. X. Seven new species of *Tylostoma*. Mycologia **36**: 318–339. 1944.
21. ——. XI. The genera *Trichaster* and *Terrostella*. Mycologia **37**: 601–608. 1945.
22. ——. XII. Five species of *Tylostoma* with membranous exoperidia. Mycologia **38**: 77–90. 1946.
23. ——. XIII. The types of Miss White's species of *Tylostoma*. Mycologia **38**: 171–179. 1946.
24. —— **and D. J. Stouffer.** XIV. The genus *Chlamydopus*. Mycologia **38**: 619–629. 1946.
25. **Longnecker, W. M.** The geasters of Iowa. Univ. Iowa Stud. Nat. Hist. **12**: 29–43. 1927.
26. **Malençon, G.** La Série des Asterosporés. Travaux cryptogamiques dédiés à Louis Mangin, pp. 377–396. 1931.
27. **Martin, G. W.** Key to the families of fungi exclusive of the lichens. Univ. Iowa Stud. Nat. Hist. **17**: 83–115. 1936.

28. ——. Outline of the fungi. Univ. Iowa Stud. Nat. Hist. **18** (Suppl.): 1–64. 1941.
29. **Morgan, A. P.** North American fungi. Jour. Cincinnati Soc. Nat. Hist. **11**: 141–149. 1889; **12**: 8–22; 163–172. 1890; **13**: 5–21. 1891; **14**: 141–148. 1892; **15**: 171–172. 1893.
30. **Pilat, A.** Sur le genre Gastrosporium Mattirolo (Gastéromycètes). Soc. Myc. France, Bul. **50**: 37–48. 1934.
31. **Rea, P. M.** Fungi of Southern California. I. Mycologia **34**: 563–574. 1942.
32. **Stevenson, J. A., and Edith K. Cash.** The new fungus names proposed by C. G. Lloyd. Lloyd Library and Museum, Bul. **35**: 1–209. 1936. (See pp. 156–203.)
33. **White, V. S.** Tylostomaceae of North America. Tor. Bot. Club, Bul. **28**: 421–444. *illus.* 1901.
34. ——. The Nidulariaceae of North America. Tor. Bot. Club, Bul. **29**: 251–280. *illus.* 1902.
35. **Zeller, S. M.** *Protogaster*, representing a new order of Gasteromycetes. Ann. Mo. Bot. Garden **21**: 231–249. *illus.* 1934.
36. ——. New and noteworthy Gasteromycetes. Mycologia **31**: 1–32. *illus.* 1939.
37. ——. Further notes on fungi. *Ibid.* **33**: 196–214. *illus.* 1941.
38. ——. Representatives of the Mesophelliaceae in North America. *Ibid.* **36**: 627–637. *illus.* 1944.

THE SPECIES OF TYMPANIS OCCURRING ON PINUS [1]

J. Walton Groves [2] and A. Mavis Leach [3]

(with 7 figures)

The problem of species identification in the genus *Tympanis* has interested the senior author for a number of years and collections and cultures have been accumulated for the purpose of making a comparative study. Special interest is attached to the species occurring on pine because of the *Tympanis* canker described by Hansbrough (**1936**) and caused by a species that could not be identified at that time. Dr. Hansbrough generously placed a large number of his collections at our disposal, and after a critical study of the available material by the junior author, we have distinguished three species occurring on pine.

These species are recognized principally by the character of the primary ascospores, which are fusiform, one- or two-celled in *T. hypopodia*, subglobose in *T. pithya*, and elongate-fusiform to clavate-fusiform and one- to several-celled in *T. confusa*.

Thirteen species of *Tympanis* have, at various times, been reported as occurring on *Pinus*. Of these, five can be eliminated at once as not being true *Tympanis* species. These are *T. pithya* (Fr.) Sacc. which will be discussed in detail below, *T. amphibola* (Massal.) Karst. (= *Pragmopara amphibola* Massal.), *T. bacillifera* Karst. (= *Pragmopara bacillifera* (Karst.) Rehm), *T. Tautziana* Ruhland which appears to be a *Biatorella* from the description and certainly can be excluded from *Tympanis* on the basis of the red color, and *T. sepiaria* Karst. which cannot be placed satisfactorily at present. No material of this species has been seen, but since no secondary ascospores have been described and the de-

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scription does not suggest a *Tympanis,* it can be excluded from this genus.

Two of the remaining names, *T. laricina* (Fckl.) Sacc. and *T. Buchsii* (Henn.) Rehm, may be disregarded as being the result of misdeterminations. *T. laricina* was originally described on *Larix* by Fuckel (**1870**) and the specimen in Fuckel Fung. Rhen. *2473* was cited. This specimen has been examined and appears to be distinct from any of the specimens on pine but does agree with other collections on *Larix*. *T. laricina* appears to be a distinct species occurring on *Larix* and any record on other hosts is probably due to a misdetermination. *T. Buchsii* was originally described by Hennings (**1903**) as occurring on *Abies*. No material of this species has been examined but studies of numerous collections and cultures of *Tympanis* species occurring on *Abies* indicate that they are distinct from the pine-inhabiting species. Therefore, it seems highly probable that reports of *T. Buchsii* on pine are also the result of misdeterminations.

Probably the best known and most frequently used name is *T. Pinastri* Tul. This name was given by Tulasne (**1865**) to a fungus that was unquestionably a *Tympanis* and was said to be on *Abies*. The name has since been applied more or less indiscriminately to any *Tympanis* found on conifers by many authors. However, it is clear from the Tulasnes' account that they considered their fungus to be *Cenangium Pinastri* Fries and their specific epithet is, therefore, based on the earlier Friesian name. Rehm (**1889**) has shown that *Cenangium Pinastri* Fries is not a *Tympanis* and has transferred it to *Tryblidiopsis*. He retained the Tulasne name for a species of *Tympanis* but this is not permissible under the International Rules. According to Article 54, *Tympanis Pinastri* Tul. must be considered as being based on Fries' type and therefore a synonym of *Tryblidiopsis Pinastri* (Fr.) Rehm. Thus, Tulasne's fungus is left without a name and the combination *Tympanis Pinastri* is invalid for any *Tympanis* species.

The descriptions of *T. farinacea* (Pers.) Rehm are so incomplete that it is impossible to decide whether or not the fungus belongs in *Tympanis*.

Of the remaining four names, the earliest is *T. pithya* (Karst.) Karst. which dates from 1867 when a specimen was issued in

Karsten's Fungi Fenniae *661* as *Patellaria pithya* Karst. with a printed description on the label. According to Articles 36 and 37 of the International Rules this is a valid publication.

In the literature, *T. pithya* Karst. has been confused with *Cenangium pithyum* Fries. Fries (**1822**) described *Cenangium pithyum* on *Pinus sylvestris* and cited the specimen in Fries Sclerom. Suec. *172*. Through the kindness of the late Dr. D. H. Linder it was possible to examine a slide of this specimen which is labelled *Excipula pithya*. This slide disclosed a fungus with filiform, many-septate ascospores. There was no evidence of secondary ascospores and the asci were not *Tympanis*-like. Evidently, therefore, *Cenangium pithyum* Fries is not a *Tympanis*.

Patellaria pithya Karst. was not based on *C. pithyum* Fr. but was published quite separately and based on the specimen in Karst. Fung. Fenn. *661* as noted above. Examination of a slide from this specimen in the Farlow Herbarium, and later examination of the specimen in Kew Herbarium, has shown that this fungus is actually a *Tympanis*. The size of the asci agrees well with the size stated in the description on the label and it has ellipsoid to subglobose primary ascospores.

Karsten (**1871a**) transferred the fungus to *Tympanis*. He did not describe primary ascospores but he cited the specimen in Fung. Fenn. *661* and the size of the asci as stated in his description agrees with that found in the actual specimen. The description given by Karsten (**1871b**) is evidently also based on the specimen in Fung. Fenn. *661*.

Confusion arose from Karsten's later description (**1871c**) in which, under the name *T. pithya*, he actually described *T. hypopodia* Nyl. and cited the specimen in Karst. Fung. Fenn. *754*. Karsten recognized that this was *T. hypopodia* for he cited it as a synonym, but he failed to realize that *T. pithya* and *T. hypopodia* were distinct species.

Saccardo (**1889**) unfortunately followed Karsten's later and erroneous account. On the basis of the two-celled primary ascospores, Saccardo made the combination *Cenangella pithya* (Karst.) Sacc. and cited *Tympanis hypopodia* Nyl. as a synonym. In the meantime, Fuckel (**1870**) had described a fungus which was really a *Tympanis* under the name of *Cenangium pithyum* Fr.

Saccardo, thereupon, created the combination *Tympanis pithya* (Fr.) Sacc. Although Saccardo was careful to point out that this was not *T. pithya* Karst. it was, of course, a later homonym of Karsten's name and invalid under the present-day rules even if Fries' fungus were a *Tympanis*.

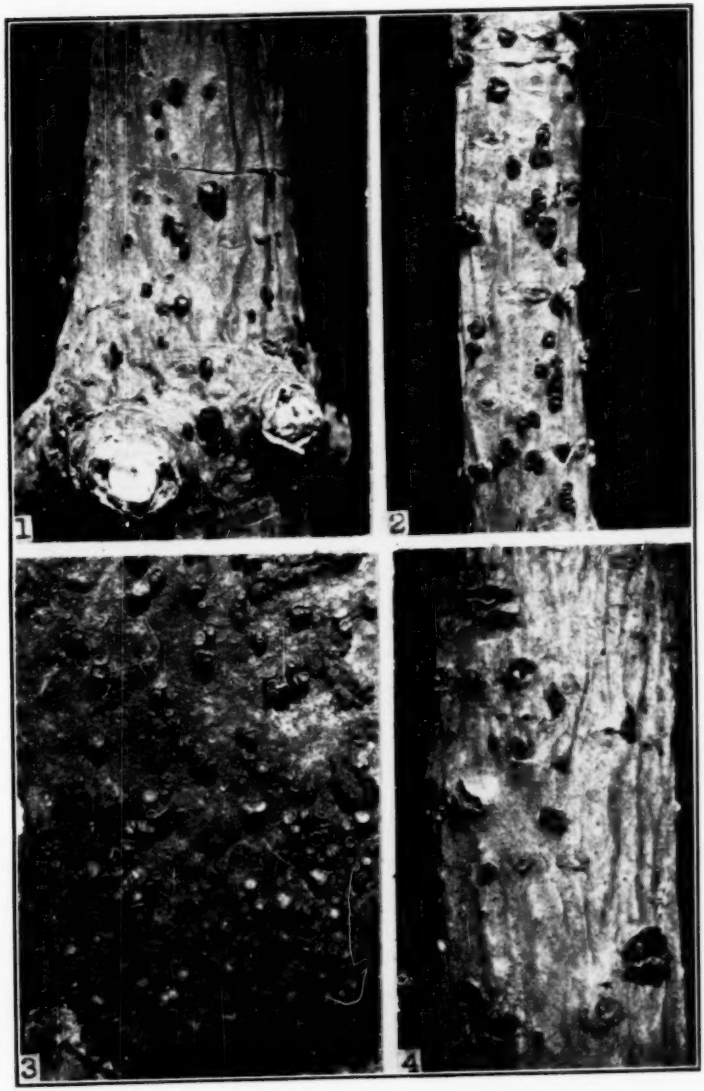
The climax to the confusion came when Rehm (**1889**) wrote the name as *Tympanis pithya* (Fr.) Karsten, a combination which never existed. Karsten at no time made any reference to *Cenangium pithyum* Fries.

Thus, *Tympanis pithya* (Karst.) Karst. is a valid name for a species of *Tympanis* occurring on pine and of which the type is Karst. Fung. Fenn. *661*; *T. pithya* (Fr.) Sacc. is a synonym of *Cenangium pithyum* Fr. whatever it may prove to be; and *T. pithya* (Fr.) Karst. is an imaginary combination that never existed in fact.

Nylander (**1868**) described three species of *Tympanis* on pine which must be considered: *T. hypopodia*, *T. confusa*, and *T. amphiboloides* var. *hypopodiza*. This is the first really critical study of *Tympanis* and Nylander was the first and for many years the only one who made an attempt to study and describe the primary ascospores.

T. hypopodia was said to have two-celled primary ascospores 8–9 × 2–3 μ in asci 8–9 μ in diameter, becoming 10–11 μ in diameter when multi-spored. The type was collected by Karsten in 1859. A specimen in Karst. Fung. Fenn. *754* collected in 1860 has been examined. It is apparently not the type but it agrees in every respect with Nylander's description and is the basis of our concept of this species.

T. confusa was described by Nylander (**1868**) based on the specimen in Fries Sclerom. Suec. *336* under the name *Patellaria atrata* Fr. Nylander found that this was really a *Tympanis* and described the primary ascospores as elongate-fusiform, 1–3-septate, 16–25 × 3–4 μ in asci 16–18 μ in diameter. The multi-spored asci were said to be 125–150 × 24–25 μ. Through the kindness of Miss E. K. Cash it was possible to examine a slide from this specimen. We found primary ascospores exactly as described but the asci were narrower, the multi-spored asci being mostly 16–18 μ in diameter and occasionally up to 21 μ.



FIGS. 1–4. Species of *Tympanis*.

T. amphiboloides var. *hypopodiza* was also described by Nylander (**1868**) and there were only two points of difference between this and *T. confusa*. The primary ascospores were said to be about the same size but seven septate with an occasional longitudinal septum, and the asci were 11–15 μ in diam., with the multi-spored asci about 100–110 × 16 μ. Saccardo (**1889**) raised it to specific rank and transferred it to *Scleroderris* on the basis of the primary ascospores but it is unquestionably a true *Tympanis*. A specimen in Karsten Fung. Fenn. *753* labelled *T. amphiboloides* var. *hypopodiza* was examined and the asci were mostly 110–140 × 16–20–(*22*) μ with elongate-fusiform primary ascospores, mostly one to three septa but occasionally more. This specimen appears to be identical with *T. confusa* from Fries Sclerom. Suec. *336*.

In the species causing the canker of red pine described by Hansbrough (**1936**), the primary ascospores were said to be 11–25 × 3–5 μ and three- to nine-septate. This has been confirmed from an examination of Hansbrough's material and thus, as far as the primary ascospores are concerned, they match both the type of *T. confusa* and the specimen in Karst. Fung. Fenn. *753* labelled *T. amphiboloides* var. *hypopodiza*. However, the asci in Hansbrough's species were said to be 12–17 μ in diameter and this was also confirmed from examination of his specimens. It was unusual for an ascus to exceed 16 μ in diameter. This agrees with the size given in Nylander's description of *T. amphiboloides* var. *hypopodiza* but is narrower than the asci observed in the Fries and Karsten specimens.

Evidently, Nylander considered that there were two species and this possibility cannot be entirely ruled out. If so, the name *T. confusa* should be used for the species with mature asci 16–20 μ in diameter, whereas var. *hypopodiza* would require a new combination in *Tympanis* and be used for the species with mature asci mostly 13–16 μ in diameter. From the material examined, septation of the primary ascospores would be a wholly unreliable character for species differentiation and the distinction would rest solely on the difference in ascus size. It seems scarcely justifiable to recognize a species on an extreme difference of 3–4 μ in the width of the asci in only two specimens of an admittedly variable group. We have, therefore, decided to regard *T. confusa* and *T.*

amphiboloides var. *hypodiza* as synonyms, of which *T. confusa* is the valid name. Hansbrough's fungus is referred to this species and the description below is based principally on his material.

The difficulty of identifying these species is enhanced by the great similarity in many of the characters. The apothecia in all three species are black, sessile to substipitate, separate or cespitose, and about the same diameter. *T. confusa* does tend to be more regular in outline, more strongly erumpent, and substipitate, whereas *T. pithya* is usually sessile and strongly undulate. The apothecia of *T. hypopodia* are usually slightly smaller than those of the other two species. However, these characters all vary considerably in different collections, often differing according to their occurrence on young twigs or more mature bark. It is not possible to identify them by the gross appearance.

The consistency and tissue structure are identical in all three and are of no value in species differentiation.

The asci, as usually observed, are multi-spored, containing hundreds of minute, hyaline spores. These are actually secondary spores and might be regarded as conidia. They, also, are similar in all three species. It generally requires careful search to find the true or primary ascospores. They are indistinct and transitory, and frequently it is impossible to find them at all. We have found no evidence that they are ever discharged from the asci.

Hansbrough (**1936**) suggested that the asci should be considered physiologically mature when the primary ascospores have been formed but not morphologically mature until the secondary ascospores are formed. Since the asci do not appear to discharge at the primary ascospore stage it is questionable whether they are really physiologically mature at this time. It is certain that they are not morphologically mature at this stage and this is an important point in the identification of species.

When the asci are in the primary ascospore stage and for some time after the secondary ascospores have begun to form, the wall of the ascus is greatly thickened and gelatinized. As the ascus approaches maturity the wall becomes thinner until it is not noticeably thicker than in asci in related genera. If measurements are made on the thick-walled asci they will be found to vary considerably,

whereas in the fully mature thin-walled asci they are relatively constant.

The size of the mature asci is, thus, of considerable value as a diagnostic character. *T. hypopodia* can be recognized with reasonable certainty from the ascus size alone, which rarely exceeds 90 μ in length and 12 μ in width. In general, the asci of *T. pithya* are slightly longer and wider than those of *T. confusa*, but there is considerable overlap in size. When most of the asci exceed 15 μ in diameter it is usually *T. pithya*, and when most of them are less than 15 μ it is usually *T. confusa*. However, the two European collections cited above proved to be exceptions and often it is impossible to place a specimen with certainty from ascus size alone in these two species. Chief reliance must be placed on the primary ascospores as a means of separating these species.

Except in *T. confusa*, where there are rarely more than four primary ascospores, the asci usually contain eight. Nylander (**1868**) spoke of the asci being up to twenty-four-spored but we have not been able to confirm this. It does seem that in the early stages of the formation of secondary ascospores, the first bodies formed are larger than the ultimate secondary ascospores. Very rarely, broken asci have been observed from which these bodies were emerging. They were larger and more irregular in size and shape than the secondary ascospores, but the true primary ascospores were not apparent. It is believed that Nylander observed something like this. Asci at this stage are very confusing for they may seem to contain numerous globose spores or several, many-septate, elongated spores, but careful search will usually reveal the true primary ascospores in other asci.

Brefeld (**1891**) stated that the secondary ascospores arose by budding from the primary ascospores, and figured primary ascospores with secondary ascospores forming as buds on the ends. We have also observed this especially in *T. pithya*, where the primary ascospores sometimes appear to bear appendages, which have been interpreted as budding secondary ascospores.

In contrast to *Dermea* (Groves, **1946**), where the conidial states proved to be of great diagnostic value in identification of species, in *Tympanis* the conidial fruiting bodies and conidia are very similar in all of the species. The fruiting bodies are usually

ovoid to cylindric, associated with more or less stromatic tissue, black, similar in consistency and tissue structure to the apothecia, and containing cavities lined with filiform conidiophores from which the conidia arise at the tip and along the sides. The conidia are indistinguishable in the various species and almost indistinguishable from the secondary ascospores, although they may be slightly larger and more variable than the latter.

Von Höhnel (**1914**) erected the genus *Pleurophomella* for the conidial states of *Tympanis* species, of which the type was *Pleurophomella cumorpha* (Penz. & Sacc.) v. Höhn., said to be the conidial state of *Tympanis Pinastri*. It is not possible to distinguish any of the conidial states of *Tympanis* species unless they are directly associated with the apothecia. If cultures can be obtained from the conidial state it may be possible to identify the species but such identifications are at best uncertain. *P. cumorpha* was originally described from *Pinus* and probably is the conidial state of one of the three species recognized in this paper but it is not possible to say to which one it belongs.

All three of these species have been studied in culture from isolations originating from both ascospores and conidia. When the asci are allowed to discharge on to agar, the whole mass of secondary ascospores forms a yeastlike colony which at first continues to grow by budding, but soon puts out a delicate fringe of hyphae. Conidia arise, not only by budding from other conidia, but also along the sides of the hyphae, forming a *Pullularia*-like colony. In older colonies, there is more extensive development of mycelium and sometimes a little whitish aerial mycelium is produced.

Cultures have been grown on two per cent malt extract agar and on sterilized twigs of the host. Conidial fruiting bodies are produced readily on agar by all three species. In *T. pithya* there is, perhaps, more tendency to produce irregular black stromatic masses which sporulate more rarely. In *T. hypopodia* the conidial fruiting bodies tend to appear later than in the other species, and to be slightly smaller and more scattered, but these characters are not clear cut and vary so much in different isolates of the same species that it does not seem possible to identify them by cultural characters alone.

On sterilized twigs they produce very little aerial mycelium but pycnidia are usually abundant and larger and more cespitose than observed in nature. Apothecia have been produced on the twigs from ascospore cultures of all three species and also from conidial cultures of *T. pithya*.

TECHNICAL DESCRIPTIONS

TYMPANIS PITHYA (Karst.) Karst. Hedw. **10**: 58. 1871. (not *T. pithya* Sacc. Syll. **8**: 583. 1889.)

Patellaria pithya Karst. Fung. Fenn. No. *661*. 1867.

Cenangella pithya Sacc. Syll. Fung. **8**: 588. 1889.

Apothecia erumpent, gregarious, separate or cespitose, usually in clusters of less than six, circular to strongly undulate, sessile, narrowed below, black, glabrous or occasionally slightly grayish-pruinose, 0.5–1.0 mm. in diameter, 0.3–0.7 mm. in height, hard, horny in consistency becoming more cartilaginous-fleshy when moist; hymenium concave to plane, dull black or shiny black, more fleshy than the excipulum, at first with a thick, somewhat infolded margin which later may disappear; tissue of the hypothecium plectenchymatous, composed of interwoven, ascending, brownish to nearly hyaline hyphae about 1–2 μ in diameter, with the walls greatly thickened and gelatinized, becoming darker and thicker at the outside forming a rind-like excipulum, subhymenium not clearly differentiated; asci cylindric to cylindric-clavate, short-stalked, at first with the walls thickened and gelatinized, becoming thinner with maturity, at first eight-spored, finally multi-spored, (80)–95–140–(165) × (11)–14–18–(22) μ; primary ascospores hyaline, broadly ellipsoid to subglobose, one- or two-celled, uniseriate, 5–8 × 3–5 μ; secondary ascospores hyaline, cylindric to allantoid, one-celled, 2.0–3.0 × 1.0–1.5 μ; paraphyses hyaline, filiform, septate, simple or branched, 1.5–2.0 μ in diameter, the tips slightly swollen to 3.0 μ and embedded in a gelatinous matrix forming a brownish epithecium.

Conidial fruiting bodies erumpent, gregarious to scattered, separate or cespitose, black, glabrous, globose or more or less ovoid, sometimes laterally confluent, 0.2–0.3 mm. in diameter, 0.2–0.4 mm. in height, similar in consistency to the apothecia; tissue plectenchymatous, similar to that of the apothecia, in the upper part containing an ovoid to slightly elongated cavity, lined with conidiophores and tearing open at the top; conidiophores hyaline, filiform, septate, simple, about 25–80 × 2.0–2.5 μ; conidia hyaline, one-

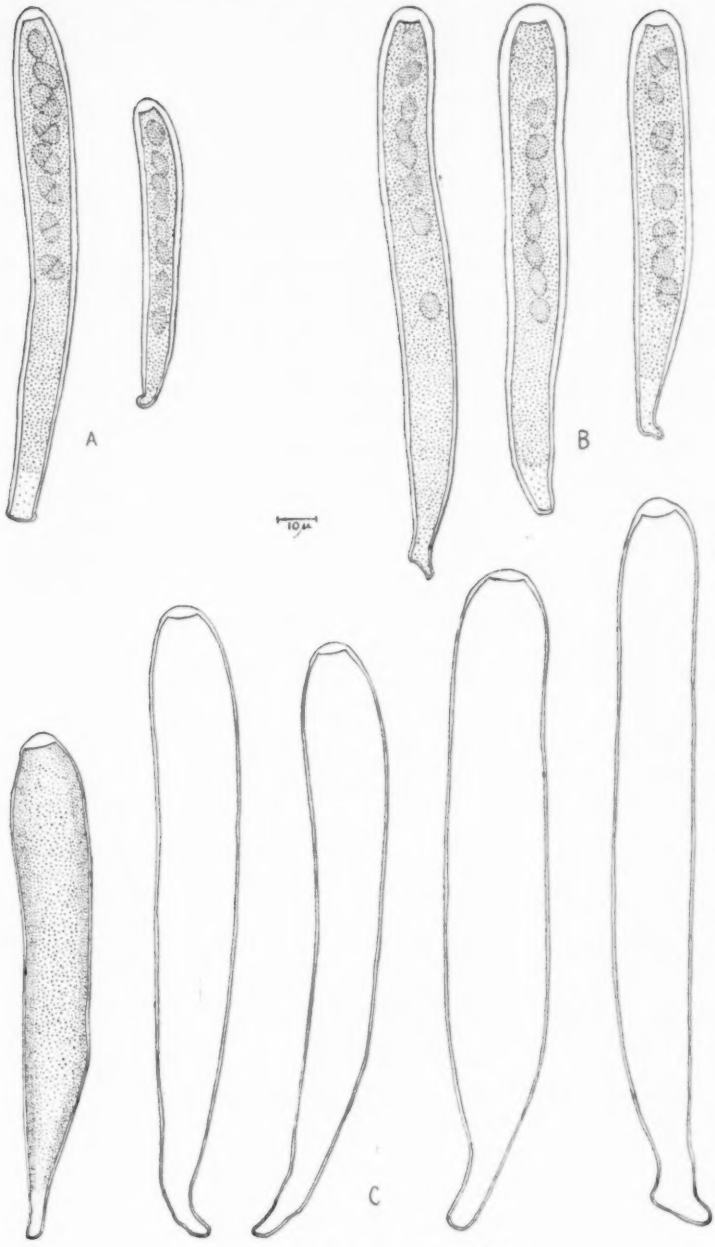


FIG. 5. Asci of *Tympanis pithya*.

celled, cylindric to allantoid, borne at the tip and along the sides of the conidiophore, 2.0–4.0 × 1.0–1.5 μ.

HOST: *Pinus strobus* L., *P. albicaulis* Engelm., *P. monticola* Dougl., *P. resinosa* Solander ex Aiton, *Pinus* spp.

EXSICCATI: Karst. Fung. Fenn. *661* Type.

SPECIMENS EXAMINED: **Canada**: Quebec: Bonaventure Co., DAOM[4] *3788;* Burnet, JWG *501;* Gatineau Park, DAOM *3828;* JWG *112;* JWG *809.* Ontario: Timagami Forest Reserve, T *3530,* JWG *39;* T *3526,* JWG *47;* T *6569,* JWG *265;* JWG *302;* JWG *481;* Charleston Lake, JWG *95;* Toronto, JWG *142;* Corkery, JWG *645.*

United States: Massachusetts: Princeton, JRH *1105,* JWG *347;* Huntingdon, JRH *1145,* JWG *367;* Topsfield, JRH *1513,* JWG *376;* Hamilton, JRH *1514,* JWG *377.* Connecticut: Hamden, JRH *1518,* JWG *379.* Vermont: Waterford, JRH *1102,* JWG *345;* Sharon, JRH *1520,* JWG *381.* New York: Lake Placid, JRH *1143,* JWG *365;* Dannemorra, JRH *1144,* JWG *366;* Canadice, JRH *1538,* JWG *388;* Alder Creek, JRH *1542,* JWG *392.* Idaho: Bonner Co., UIFP *2490,* JWG *761;* UIFP *1980B,* JWG *781.* California: Mt. Shasta, WBC *18043,* JWG *833;* WBC *20487,* JWG *867.*

TYMPANIS CONFUSA Nyl. Obs. Pez. Fenn. p. 69. 1868.

Tympanis amphiboloides var. *hypopodiza* Nyl. Obs. Pez. Fenn. p. 71. 1868.

Scleroderris hypopodiza Sacc. Syll. Fung. **8**: 597. 1889.

Apothecia erumpent gregarious, separate or cespitose, usually with less than six in a cluster but occasionally in large clusters of fifteen or more, circular or slightly undulate, sessile to substipitate, narrowed below, 0.5–1.5 mm. in diameter, 0.4–2.0 mm. in height, black, glabrous, hard, horny in consistency, becoming more cartilaginous-fleshy when moist; hymenium concave to plane, dull black or shiny black, more fleshy than the excipulum, at first with

[4] The code letters refer to the following herbaria: DAOM, Mycological Herbarium of the Division of Botany and Plant Pathology, Central Experimental Farm, Ottawa; T, Mycological Herbarium of the University of Toronto; UIFP, University of Idaho, Forest Pathology Herbarium; JWG, Herbarium of J. W. Groves; JRH, Herbarium of J. R. Hansbrough; WBC, Herbarium of Wm. Bridge Cooke.

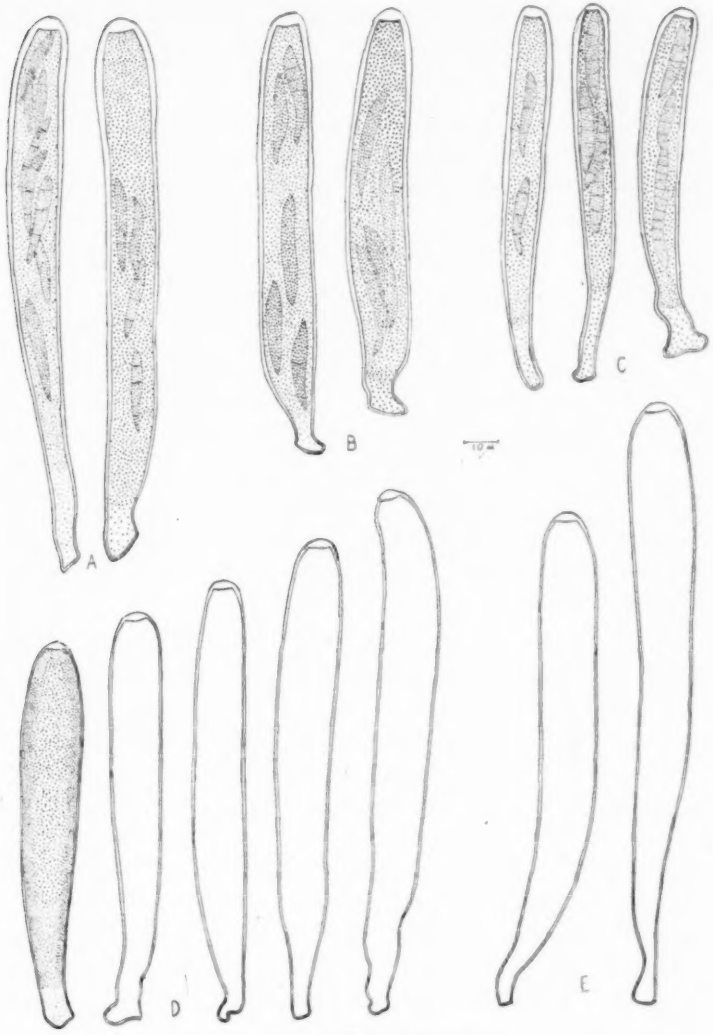


FIG. 6. Asci of *Tympanis confusa*.

a thick, somewhat infolded margin which later may disappear; tissue of the hypothecium plectenchymatous, composed of interwoven, ascending, brownish to nearly hyaline hyphae about 1–2 μ in diameter, with the walls greatly thickened and gelatinized, becoming thicker and darker at the outside forming a rind-like ex-

cipulum, subhymenium not clearly differentiated; asci cylindric to cylindric-clavate, short-stalked, at first with the walls thickened and gelatinized, becoming thinner with maturity, at first 1–4–(8)-spored, finally multi-spored, (80)–85–120–(150) × (10)–12–16–(21) μ; primary ascospores hyaline, elongate-fusoid to clavate-fusoid, one- to several-celled, occasionally muriform, irregularly biseriate to uniseriate, 13–20 × 2–4 μ; secondary ascospores hyaline, cylindric to allantoid, one-celled, 2.0–3.0 × 1.0–1.5 μ; paraphyses hyaline, filiform, septate, simple or branched, 1.5–2.0 μ in diameter, the tips slightly swollen to 3.0 μ and embedded in a gelatinous matrix forming a brownish epithecium.

Conidial fruiting bodies erumpent, scattered to gregarious, separate or cespitose, black, glabrous, globose to ovoid, sessile, 0.2–0.3 mm. in diameter, or sometimes on long, branched, cylindric or irregular stalks 0.1–0.3 mm. in diameter and up to 2.0 mm. in height, consistency similar to the apothecia; tissue plectenchymatous, similar to that of the apothecia, in the upper part containing a globose to ovoid cavity lined with conidiophores and tearing open at the top; conidiophores hyaline, filiform, septate, simple, about 25–60 × 2.0–2.5 μ; conidia hyaline, one-celled, cylindric to allantoid, borne at the tip and along the sides of the conidiophore, 2.0–4.0 × 1.0–1.5 μ.

HOST: *Pinus resinosa* Solander ex Aiton, *P. strobus* L., *P. albicaulis* Engelm., *P. monticola* Dougl., *P. contorta* Dougl., *P. sylvestris* L., *Pinus* spp.

EXSICCATI: Fries Sclerom. Suec. *336* (as *Patellaria atrata* β); Karst. Fung. Fenn. *753* (as *T. amphiboloides* var. *hypopodiza*).

SPECIMENS EXAMINED: **Canada**: Ontario: Petawawa Forest Experiment Station, JWG *688*.

United States: Connecticut: Woodbridge, JRH *1126*, JWG *359*; JRH *1134*, JWG *361*; JRH *1136*, JWG *362*; JRH *1509*, JWG *373*; Branford, JRH *1131*, JWG *360*; Windsor, JRH *1120*, JWG *357*; JRH *1108*, JWG *348*; JRH *1109*, JWG *349*; Prospect, JRH *1110*, JWG *350*; Bethany, JRH *1111*, JWG *351*; Hamden, JWG *878* (separated from JWG *379 T. pithya*). New York: Alder Creek, JRH *1544*, JWG *400*; JRH *1543*, JWG *393*; Canadice, JRH *1539*, JWG *389*; JRH *1540*, JWG *390*; Olive, JRH *1541*, JWG *391*. Idaho; Bonner Co., UIFP *2000B*, JWG *756*. Oregon: Rhododendron, JRH *1117*, JWG *355*; JRH *1118*, JWG *356*.

TYMPANIS HYPOPODIA Nyl. Obs. Pez. Fenn. p. 72. 1868.

Apothecia erumpent, gregarious, separate to cespitose with usually less than six in a cluster, circular or undulate, sessile to sub-

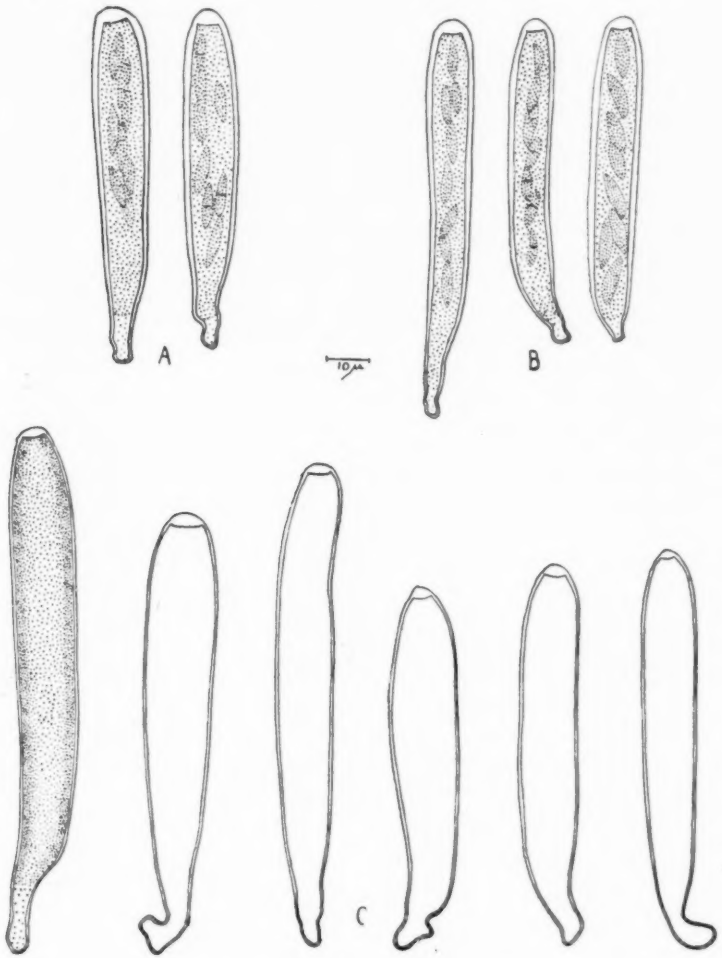


FIG. 7. Asci of *Tympanis hypopodia*.

stipitate, narrowed below, 0.5–1.0 mm. in diameter, 0.3–1.5 mm. in height, black, glabrous, hard, horny in consistency, becoming more cartilaginous-fleshy when moist; hymenium concave to plane,

black, more fleshy than the excipulum, at first with a thick, somewhat infolded margin which later may disappear; tissue of the hypothecium plectenchymatous, composed of interwoven, ascending, brownish to nearly hyaline hyphae about 1–2 μ in diameter, with the walls greatly thickened and gelatinized, becoming thicker and darker at the outside forming a rind-like excipulum, subhymenium not clearly differentiated; asci cylindric to cylindric-clavate, short-stalked, at first with the walls thickened and gelatinized, becoming thinner with maturity, at first eight-spored, finally multi-spored, (60)–70–90–(100) × (8.5)–9.0–12.0–(14) μ; primary ascospores hyaline, fusiform, one- or two-celled, irregularly biseriate, (6)–8–10–(12) × 2.0–4.0 μ; secondary ascospores hyaline, cylindric to allantoid, one-celled, 2.0–3.0 × 1.0–1.5 μ; paraphyses hyaline, filiform, septate, simple or branched, 1.5–2.0 μ in diameter, the tips slightly swollen up to 3.0 μ and embedded in a gelatinous matrix forming a brownish epithecium.

Conidial fruiting bodies erumpent, gregarious to scattered, separate or cespitose, black, glabrous, globose to ovoid or cylindric, sessile, 0.1–0.3 mm. in diameter, 0.1–0.3 mm. in height, similar in consistency to the apothecia; tissue plectenchymatous, similar to that of the apothecia, in the upper part containing a globose to ovoid cavity lined with conidiophores and tearing open at the top; conidiophores hyaline, filiform, septate, simple, 25–70 × 2.0–2.5 μ; conidia hyaline, cylindric to allantoid, one-celled, borne at the tip and along the sides of the conidiophore, 2.0–4.0 × 1.0–1.5 μ.

HOST: *Pinus strobus* L., *P. monticola* Dougl., *P. cembra* L., *P. rigida* Mill., *P. resinosa* Solander ex Aiton, *Pinus* spp.

EXSICCATI: Karst. Fung. Fenn. *754;* Rel. Farl. *156b* (as *T. Pinastri*); Rab. Fung. Eur. *1231* (as *T. Pinastri*).

SPECIMENS EXAMINED: **Canada**: Ontario: Timagami Forest Reserve, JWG *327;* JWG *300;* Petawawa Forest Experiment Station, JWG *564;* Corkery, JWG *879*.

United States: Massachusetts: Sunderland, JRH *6*, JWG *334;* Ipswich, JRH *1512*, JWG *375*. Connecticut: East Granby, JRH *1104*, JWG *346*. Idaho: Shoshone Co., UIFP *2343*, JWG *707;* Bonner Co., UIFP *2726*, JWG *763;* UIFP *1848A*, JWG *780;* Clearwater Natl. Forest, DAOM ex Herb. J. R. Weir *16615*.

ACKNOWLEDGMENTS

The authors are indebted to Dr. J. R. Hansbrough, Dr. John Ehrlich, and Mr. Wm. Bridge Cooke for contributions of speci-

mens; to Dr. R. W. G. Dennis for making specimens in Kew Herbarium available for examination; and to Miss E. K. Cash and the late Dr. D. H. Linder for the loan of slides of exsiccati.

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LITERATURE CITED

Brefeld, O. 1891. Untersuchungen aus dem Gesammtgebiete der Mykologie. (Stictideen, Dermateaceen.) X Heft: Ascomyceten II. Munster.

Fries, E. M. 1822. Systema mycologicum **2**: 1–275.

Fuckel, L. 1870. Symbolae mycologicae. Jahrb. Nass. Ver. Naturk. **23–24**: 1–459.

Groves, J. W. 1946. North American species of *Dermea*. Mycologia **38**: 351–431.

Hansbrough, J. R. 1936. The *Tympanis* canker of red pine. Yale University: School of Forestry Bulletin **43**. 58 pp., pls. I–XII.

Höhnel, F. von. 1914. Fragmente zur Mykologie. Sitzb. k. Akad. Wissensch. Wien, Math.-nat. Kl. Bd. **123**: 1–107.

Karsten, P. A. 1871a. Species nonnullae fungorum novae. Hedw. **10**: 55–59.

——. 1871b. Symbolae ad Mycologiam Fennicam 1. Notis. ur Sällsk. pro Faun. et Fl. Fenn. Förh. **11**: 211–276.

——. 1871c. Mycologia Fennica. Pars prima. Discomycetes. Bidr. t. kännedom af Finl. nat. o. folk **19**: 1–263.

Nylander, W. 1868. Observationes circa Pezizas Fenniae. Notis. ur Sällsk. pro Faun. et Fl. Fenn. Förh. **10**: 1–97.

Rehm, H. 1889. Ascomyceten: Hysteriaceen und Discomyceten. Rabh. Krypt.-Fl. von Deutschland, Österreich und der Schweiz. *2* Aufl. Die Pilze. III Abt. Leipzig. 209–336.

Saccardo, P. A. 1889. Sylloge fungorum **8**: 1–1143.

Tulasne, L. R., and C. Tulasne. 1865. Selecta Fungorum Carpologia. **3**. (Transl. by Grove) Paris.

EXPLANATION OF FIGURES

FIG. 1. Apothecia of *T. confusa*. FIG. 2. Apothecia of *T. pithya*. FIG. 3. Apothecia of *T. hypopodia*. FIG. 4. Conidial state of *T. pithya*. All × 4 approx.

FIG. 5. Drawings of asci of *T. pithya*; *A*, asci with primary ascospores from Karst. Fung. Fenn. *661, type*; *B*, asci with primary ascospores from North American material; *C*, five mature asci from North American material.

FIG. 6. Drawings of asci of *T. confusa; A*, asci with primary ascospores from Fries Sclerom. Suec. *336, type; B*, asci with primary ascospores from Karst. Fung. Fenn. *753* labelled *T. amphiboloides* var. *hypopodiza; C*, asci with primary ascospores from North American material; *D*, five mature asci from North American material; *E*, two mature asci from Fries Sclerom. Suec. *336*.

FIG. 7. Drawings of asci of *T. hypopodia; A*, asci with primary ascospores from Karst. Fung. Fenn. *754; B*, asci with primary ascospores from North American material; *C*, six mature asci from North American material.

THE GENUS CERACEA CRAGIN

G. W. Martin

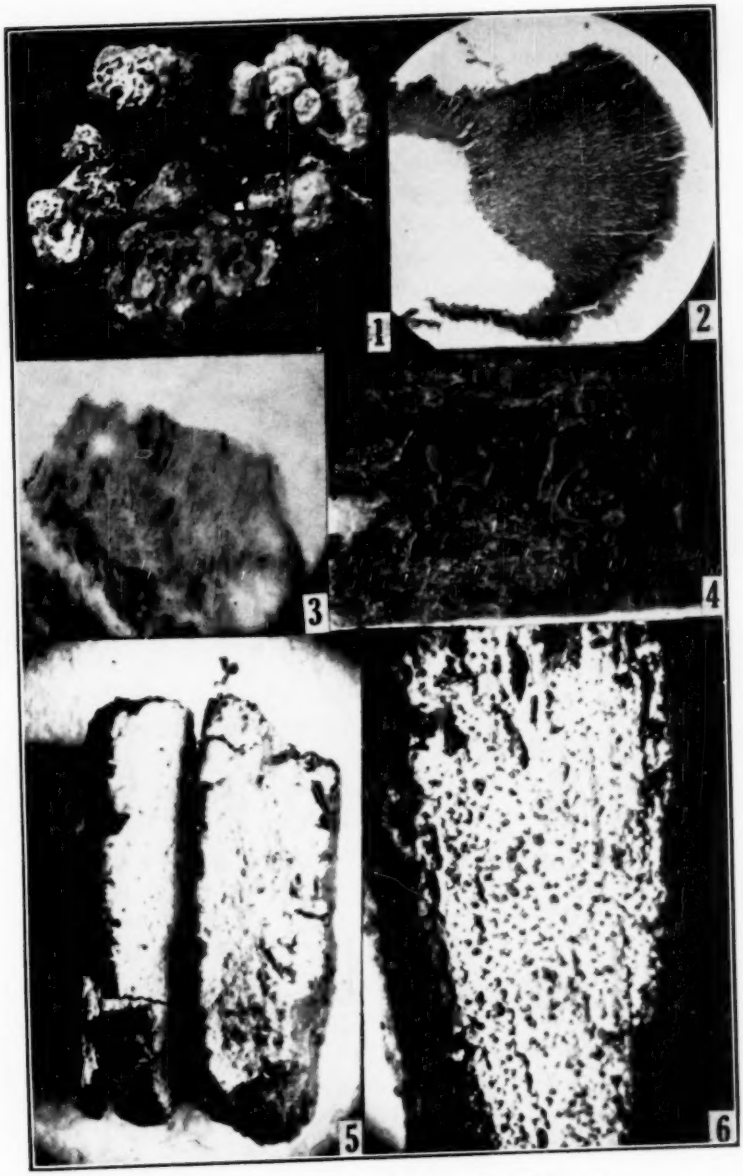
(with 13 figures)

The genus *Ceracea* was established by Cragin (Bull. Washburn Coll. Lab. Nat. Hist. **1**: 82. 1884) on the basis of a single collection which consisted of a waxy incrustation covering a cluster of pilei of a pore fungus, referred to as "apparently *P. versicolor.*" The essential characters in Cragin's generic description were the effused, waxy habit and the "mostly bifurcate" sporophores. In the description of the type species, *C. vernicosa,* the spores are said to be borne "at the apices of the basidia." The clear inference from these statements is that *Ceracea* is a member of the Dacrymycetaceae characterized by a broadly effused, waxy basidiocarp. As such it was accepted by Patouillard (Bull. Soc. Myc. Fr. **9**: 141. 1893), who assigned to it a second species from Ecuador, by Hennings (in Engler and Prantl, Nat. Pfl. I. **1****: 99. 1897), by Bresadola (in Krieger, Fungi Sax. No. *1909.* 1906), who recorded a species from Saxony, by Bourdot and Galzin (Bull. Soc. Myc. Fr. **39**: 266. 1923), who added an additional species from France, by Killermann (in Engler and Prantl, Nat. Pfl. ed. 2. **6**: 120. 1928) and by several authors since.

Lloyd (Myc. Notes **6**: 899. 1920) stated that there is no doubt that *Ceracea* Cragin is the same as *Arrhytidia* Berk. & Curt. published many years earlier. The comment by Coker (Jour. Elisha Mitchell Soc. **43**: 237. 1928) implies that he agreed with Lloyd. Killermann cites Berkeley's genus as a synonym of *Ceracea.* Why, in such case, he did not use the earlier name is not clear, but the form of citation suggests that he may have supposed it to be a *nomen nudum.* Brasfield (Am. Midl. Nat. **20**: 213. 1938) cited "*Ceracea* auct. not Cragin" as a synonym of *Arrhytidia* but later (Lloydia **3**: 106. 1940) he recorded an Iowa collection referred to *Ceracea crustulina* Bourd. & Galz. and gave it as his opinion that the genus *Ceracea* is valid but should be "restricted to

the thin, resupinate, easily separable forms which show no evidence of distinct rooting portions." Jackson and Martin (Mycologia **32**: 693. 1940) accepted the genus on that basis and added an additional species, and, with elimination of the reference to the separable character, it was the sense in which I adopted it in the survey of the Tremellales of the north central United States (Univ. Iowa Stud. Nat. Hist. **18**[3]: 23. 1944), restricting *Arrhytidia* to those species which are at first discoid or pustulate and rooted at the center but which early anastomose and form a more or less continuous film.

Some years ago I was informed that most of Cragin's specimens had been destroyed by fire and that the type of *C. vernicosa* was probably among them. Recently, however, Dr. D. P. Rogers has discovered in the Ellis collection at the New York Botanical Garden what is undoubtedly a substantial part if not all of the material on which Cragin's genus was based (FIG. 1) and it is therefore possible to clarify our conception of it. There are seven sporophores or clusters of a pore fungus, together with a few smaller fragments, quite probably representing *Polyporus versicolor*, as Cragin suggested. The upper surface is completely and the lower surface partly covered by a dull, reddish-brown, horny incrustation. The interior has been largely destroyed by insects but the surface has apparently been untouched (FIG. 2). When soaked, the surface layer becomes waxy and paler. Microscopic examination shows that this region is composed of densely packed, branching conidiophores (FIG. 3), the spore-bearing branchlets often more or less thickened, sometimes notably so, and the terminal branchlets often in pairs (FIG. 7), suggesting basidia of the *Dacrymyces*-type. The spores are borne profusely, much of the outer, horny portion being composed of densely agglutinated spores. They are apparently borne singly. No chains were observed and there is only one point of attachment visible on each spore. The shape is irregular; some are suballantoid and look like *Dacrymyces* spores, but the majority are ovate, tear-shaped, oblong or irregular. Empty spore-case cases suggest that in some instances the contents have slipped out. In size they are mostly 6–10 × 3–5 μ with a few spores above and below these limits.



FIGS. 1–6. *Ceracea*, *Arrhytidia* and *Cerinomyces*.

Obviously *Ceracea* is an imperfect fungus, to be classed with the Moniliaceae, possibly near *Monosporium*. Its removal from the Dacrymycetaceae raises the question whether the broadly effused, subarid or waxy species belonging to that family and heretofore referred to *Ceracea* may properly be included in *Arrhytidia* or should have a new genus erected for them.

The original generic description of *Arrhytidia* Berk. & Curt. (Hooker's Jour. Bot. and Kew Misc. **1**: 235. 1849) is as follows: "Hymenophorum a mycelio mucedineo contexto formatum marginatum, tectum hymenio ceraceo molli laevi sine plicis. Sporae oblongae." The emphasis is on the smooth, waxy hymenium with mycelioid margin. The description of the type species, *A. flava* Berk. & Curt., immediately following, adds that the species occurs on pine branches, that it forms scattered, sometimes confluent patches, that the hymenium is orange-yellow, bordered by the white mycelial margin and that the spores are obliquely attached. Berkeley summarizes his conception by comparing it with *Psilopezia* and adding: "It is a distinctly bordered, mostly pezizaeform *Merulius*, destitute of folds." Shortly thereafter Fries (Nova Acta Soc. Sci. Upsal. III. **1**: 114. 1851) stated that under the microscope *Arrhytidia* had the organization of a *Dacrymyces* and that in an old fructification it could scarcely be distinguished from that genus.

Patouillard (Bull. Soc. Myc. Fr. **11**: 211. 1895), in describing new species of *Guepiniopsis* from Ecuador, states of two of them that they might perhaps be referred to *Arrhytidia* because of the pezizoid form of their fructifications. These, it will be noted, are cupulate and stipitate species and the emphasis is therefore on Berkeley's use of the word pezizaeform. He adds: "ce dernier genre [*i.e.*, *Arrhytidia*] ne présente pas de caractères tranchés le séparant de *Guepiniopsis*. *A. flava* Berk., dont nous avons pu étudier des spécimens authentiques, a un pied radicant et des dimensions plus grandes, mais tous ses autres caractères sont ceux de *G. andinus*." Further on, he emphasizes the intermediates between the genera of the Dacrymycetaceae as then recognized, but cites the "plaques corticioïdes" of *Ceracea* as representing one extreme.

Coker, in the 1928 paper cited, proposed the name *Arrhytidia involuta* (Schw.) Coker, based on *Dacrymyces involutus* Schw., reducing *A. flava* Berk. & Curt., *Dacrymyces corticioides* Ell. & Ev., *Ceracea corticioides* (Ell. & Ev.) Pat. and *Ceracea aureo-fulva* Bres. to synonymy, and was inclined to agree with Lloyd that *Ceracea Lagerheimii* Pat. is also a synonym.

Miss E. M. Wakefield has kindly examined the type of *Arrhytidia flava* at Kew and has compared it with the type of *Ceracea aureo-fulva* in the British Museum, and states: "I think they are certainly not the same species. Whether they belong to the same genus, I am not sure. . . . The spores of *Ceracea aureo-fulva* Bres. are as described, 11–17 × 5½–7 μ, but I was unable to see any septation in the British Museum specimen. The spores of *Arrhytidia flava* (type) are larger, 20–25 × 7–8 μ and become 3-septate." She adds that Ravenel No. *1016* from South Carolina appears to be similar, but a specimen from Alabama, collected by Peters and named by Berkeley, has smaller spores, is obviously gelatinous and may be *Dacrymyces involutus, i.e., Arrhytidia involuta* Coker, 1928. A specimen from Coker, sent as *D. involutus*, is effused, but was obviously gelatinous when fresh and has the smaller spores.

Dr. Walter H. Snell, of Brown University, has permitted me to examine a collection from the Curtis Herbarium labelled "*Arrhytidia flava* B. & C. Ala.," presumably in Curtis' hand. The specimen consists of a small rectangle of decorticated wood, about 3 × 1.5 cm. in size, bearing a number of flat, discoid, often anastomosing fructifications (FIG. 4). The substratum appears to be wood of a soft, frondose tree, possibly *Liriodendron* or *Populus*; it is certainly not that of a conifer. The color, dry, is about Mikado Brown (R)[1] with paler (Clay Color R) margins. The individual disks, when free, range from 1 to 2.5 mm. in diameter, each attached by a stout, root-like base. Anastomosis apparently begins rather early and causes the disks to become irregular in outline, but in no case was the junction between adjacent disks completely obliterated. The basidia are typical of the family

[1] (R) refers to color terms as used by Ridgway, Color Standards and Nomenclature. 1912.

(FIG. 8). There may be a clamp-connection at the base of each basidium, but since the supporting hyphae collapse early, this is not clear. Clamp-connections are abundant on the internal hyphae and are of the loop type characteristic of gelatinous Basidiomycetes. The few spores seen were short-cylindrical and adaxially depressed or suballantoid, 14–16 × 5.5–7 μ. No septate spores were seen. This specimen agrees with the Peters collection from Alabama as described by Miss Wakefield and essentially with Coker's description of *A. involuta* except for the absence of septate spores.

It seems clear that the specimens which have been referred to *Arrhytidia* and to *Ceracea* (exclusive of the type) fall into two groups. One group originates as pustules, each pustule rooted in the substratum, but anastomosing early and forming reticulate or more or less continuous, tough-gelatinous or subgelatinous films, drying horny. The members of the other group originate as corticioid plaques on a mycelial base, becoming broadly effused, are without conspicuous rooting bases and are waxy to subfleshy in consistency, drying arid. For the members of the first group the generic name *Arrhytidia* is available. The members of the second group are, in my opinion, generically distinct and, since *Ceracea* is not available, I propose for them the following genus:

Cerinomyces gen. nov.

Fructificationibus resupinatis, late effusis, eradicatis; hymenio leve vel tuberculoso, texto subarido vel ceraceo non gelatinoso; basidiis clavatis demum bifurcatis.

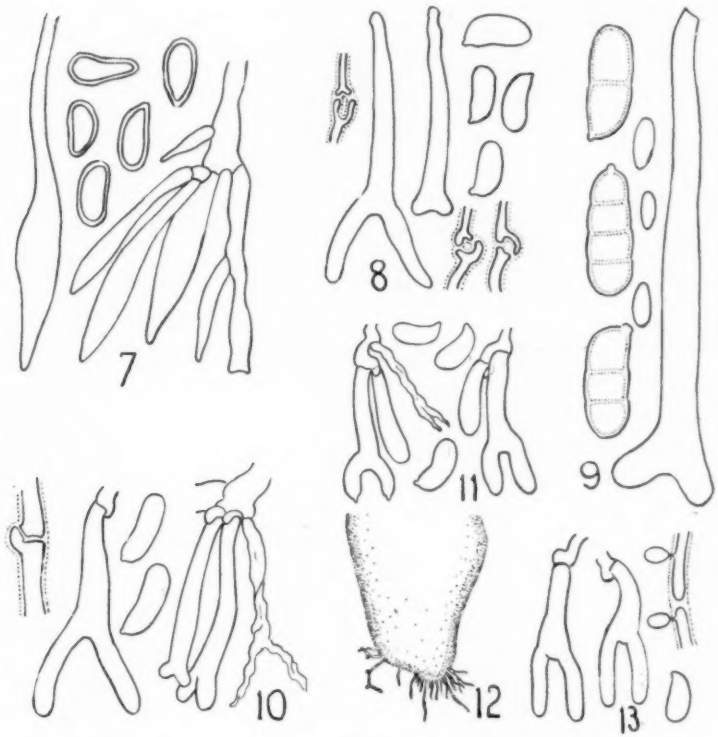
Thin, resupinate, originating as flat hymenial areas on a mycelial base, quickly becoming effused, without rooting bases, subarid to waxy, not gelatinous; hymenium smooth, spiny or tuberculate, composed of densely packed basidia and paraphyses; basidia at first cylindrical, then clavate, finally furcate by the development of two thick epibasidia, each of these tipped by a sterigma and a basidiospore; basidiospores cylindrical to allantoid, remaining simple or becoming transversely septate.

Name from κήρινος (waxy) + μύκης.

Type species:

Cerinomyces pallidus sp. nov.

Fructificatio ceracea aut aride-carnosa haud a tuberculis radicantibus orta, sed ut plagula minuta in reticulo crasso strata, inde latissime effusa, denique ultra 14 × 3 cm. effusa; hymenio vivo pallido vel isabellino, in vetustate olivaceo-fulvo, arescente pallido aut isobellino usque ad ravum; strato hymeniale levi, vel papillis



FIGS. 7–13. *Ceracea, Arrhytidia* and *Cerinomyces.*

aut aculeis parcissime inaequalibus vel subinde densissime gregariis notato; probasidiis cylindraceo-clavatis, 11–13 × 3–4 μ, duo epibasidia crassiuscula breva gerentibus; basidiis maturis apice furcatis 18–22 μ in toto longitudine; sporis cylindraceis, curvulis, 7–8 × 4–4.5 μ, integris.

Waxy to arid-fleshy, not originating as rooted tubercles, beginning as small corticioid plaques on a coarse mycelial network, becoming broadly effused, finally attaining dimensions of 14 × 3

cm. or more; hymenium, when fresh, dingy white to tilleul buff (R) or tawny olive (R) in the thicker and older portions, pallid or tilleul buff (R) to cinnamon drab (R) at margin, smooth or marked with sparsely scattered or sometimes densely clustered spines or tubercles; probasidia cylindrical-clavate, 11–13 × 3–4 μ, producing two rather short and thick epibasidia; mature basidia furcate, 18–22 μ in total length; basidiospores cylindrical, more or less curved, (6–)7–8(–9) × (3–)4–4.5 μ, remaining unseptate.

IOWA: Iowa City, on rotten oak, 28 July 1939, G. W. M. *4673*, **type**; also G. W. M. *5180*, on oak, and *3914, 3916, 5106, 5500*, on apple, all collected in Iowa City in 1939 and 1940, and from May to November.

These are the collections previously referred to *Ceracea crustulina* Bourd. & Galz. by Brasfield and myself. Through the kindness of Dr. Marcel Locquin I have been permitted to examine a portion of the type of *C. crustulina* labelled "Pl. du Gard, Galzin No. *5793*." The material seen consists of a continuous film about 8 × 2 mm. in extent, with a marginal area characterized by a coarse mycelial weft bearing scattered fruiting areas varying from less than 1 mm. across down to mere expansions at the junction of the mycelial strands. The color of the fruiting area in dry material is very close to brownish drab (R). In the continuous portion there is evidence of the fusion of separate appressed patches similar to those in the marginal area. The texture is subfleshy, not horny, and there is no reason to believe that it is at all gelatinous when soaked. The probasidia are cylindrical-clavate, 20–25 × 2–4 μ before the development of the epibasidia, becoming forked in characteristic dacrymycetaceous fashion; the basidiospores are cylindrical, slightly curved, without septa so far as observed, 10–10.5 × 3.5–4 μ. These measurements are in substantial agreement with those given in the original description. Each basidium has a clamp-connection at the base and there are numerous clamp-connections on the internal hyphae. The microscopic details are shown in figure 10.

The Iowa collections here included in *Cerinomyces pallidus* are obviously closely related to *Ceracea crustulina*, but differ in the shorter and relatively stouter basidia and smaller spores (FIGS. 11, 13), the occurrence of tubercles and spines on the older hy-

menial surface (FIGS. 5, 6, 12) and in the generally more pallid color, although this last character is probably of little significance. Some of the spines bear protruding hairs at the tip (FIG. 12) and these were observed in one instance (FIG. 13, right) to bear conidia. This may have been a response to moist conditions after collection when a spore-print was being secured.

While it would ordinarily be desirable to designate one of the older species as the type of the genus, in the present instance the abundance of material of the Iowa species, permitting wide distribution of type or authentic specimens, seems to make it desirable to designate *C. pallidus* as the type.

The following new combinations are proposed: **Cerinomyces crustulinus** (Bourd. & Galz.) comb. nov., based on *Ceracea crustulina* Bourd. & Galz. Bull. Soc. Myc. France **39**: 266, 1924 and **Cerinomyces canadensis** (Jacks. & Martin) comb. nov., based on *Ceracea canadensis* Jacks. & Martin, Mycologia **32**: 693. 1940.

The concept of *Arrhytidia* here suggested is that, except for its firm-gelatinous or waxy texture, it is similar to *Dacrymyces* in its earlier stages, beginning as a group of rooted pustular or discoid fructifications which soon anastomose and eventually form a netted or more or less continuous film on the substratum. The type is *A. flava* Berk. & Curt. *A. involuta* (Schw.) Coker is probably distinct; the difference in spore size alone between the two species is far beyond the limits ordinarily regarded as possible within a single species. *A. enata* (Berk. & Curt.) Coker and *A. pustulata* Brasf. appear to be valid. *Ceracea aureo-fulva* Bres. and *C. Lagerheimii* Pat. may also be synonyms of *A. involuta*, as Coker was inclined to believe, but as to these I should be inclined to reserve judgment. I reproduce drawings (FIG. 9) from the type of *C. Lagerheimii*, now in the Farlow Herbarium, for purposes of comparison. These were made many years ago and I unfortunately did not at the time make notes of other features, but the large, gelatinous-walled spores with thick septa and the abundant conidia suggest that the species may be distinct from *A. involuta* although closely related and to be included in the same genus. *C. elongata* Pat. (Mem. Acad. Malgache **6**: 9. 1928) from Madagascar, with very large, finally 7-septate spores, appears to be clearly distinct and should, perhaps, also be referred to *Arrhytidia*.

Cerinomyces is effused from the first, the fructification beginning as small fertile areas on a loose subiculum and spreading by anastomosis and extension. It lacks the prominent rooting bases of *Arrhytidia* and the texture is fleshy to arid, in this respect and in manner of growth and appearance suggesting *Corticium* or, when the hymenium is tubercular, *Grandinia*. *C. pallidus* is the type species, *C. crustulinus* (Bourd. & Galz.) and *C. canadensis* (Jacks. & Mart.) are the other species known.

I am indebted to Dr. Donald P. Rogers for calling my attention to the existence of the type of *Ceracea vernicosa* Cragin in the Ellis Collection and to the fact that it is an imperfect fungus, and for valuable critical suggestions; to the New York Botanical Garden for the loan of the material; to Miss E. M. Wakefield for notes on the type of *Arrhytidia flava* Berk. at Kew and for comparison of that collection with the specimen of *Ceracea aureo-fulva* Bres. in the British Museum; to Dr. Walter H. Snell and Brown University for the loan of the Alabama collection of *A. flava* in the Curtis Collection, and to Dr. Marcel Locquin for the loan of the type of *Ceracea crustulina* Bourd. & Galz.

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EXPLANATION OF FIGURES

FIGS. 1–3. *Ceracea vernicosa*. FIG. 1. Type collection, × 4½. FIG. 2. Section through hollow pileus of *Polyporus*, covered by gelatinous crust of *Ceracea*, enlarged. FIG. 3. Detail of marginal tuft, showing closely packed mass of conidiophores and spores, greatly enlarged. FIG. 4. *Arrhytidia involuta*. Photograph of specimen in Curtis collection labelled "*Arrhytidia flava* B. & C.," × 4. FIGS. 5–6. *Cerinomyces pallidus*. FIG. 5. No. *5106*, with smooth hymenium, on apple. FIG. 6. No. *3916*, with tuberculate hymenium, on oak, × 4.

FIG. 7. *Ceracea vernicosa*. Single conidiophore, cluster of conidiophores and conidia, × 1000. FIG. 8. *Arrhytidia involuta*. Basidia, clamp-connections on internal hyphae and basidiospores, from Curtis specimen labelled *A. flava*, × 570. FIG. 9. *Ceracea Lagerheimii*. Basidium, basidiospores and conidia, from type, × 1000. FIG. 10. *Cerinomyces crustulinus*. Basidium, cluster of basidia, clamp-connection from internal hypha and basidiospores, from type of *Ceracea crustulina*, × 1000. FIGS. 11–13. *Cerinomyces pallidus*. FIG. 11. Basidia and basidiospores of No. *4673*, **Type,** on oak, × 1000. FIG. 12. Diagrammatic section through tubercle of No. *3914*, on apple, × 55. Note hymenial conidia on protruding hairs, lower left. FIG. 13. Basidia, basidiospore and hymenial conidia of same, × 1000.

NOTES AND BRIEF ARTICLES

A Note on the Genus Kuntzeomyces

(with 1 figure)

P. Hennings (Hedwigia **36**: 246. 1897) described the monotypic genus *Didymochlamys* and its type species *D. ustilaginoidea*, occurring on ovaries of *Rhynchospora* sp. collected by Ule in Brazil. The generic name was later changed by Saccardo (Syll. Fung. **14**: 430. 1899), apparently at Hennings' request, to *Kuntzeomyces* to avoid confusion with Hooker's Rubiaceous genus *Didymochlamya*.

Von Hoehnel (Sitzb. Akad. Wiss. Wien Math. Nat. Kl. **119**: 2–4. 1910) studied Hennings' type and provided a more complete description, commenting in particular on the spores with very thick, three-layered membranes or walls. He did not feel that the fungus was generically distinct from *Cintractia* and he accordingly set up the new combination *C. ustilaginoidea* (P. Henn.) Hoehn. Dietel (in Engler and Prantl, Nat. Pflanzenfam. (ed. 2) **6**: 19. 1928) discusses the fungus as *Kuntzeomyces* and illustrates the spores diagrammatically. He assigns it to the Tilletiaceae in contrast to Hennings who placed it in the Ustilaginaceae. Until the spores have been germinated its family classification remains problematical although there is no reason to believe it belongs other than to the latter family. Clements and Shear (The Genera of Fungi, pp. 156 and 340. 1931) set up a new name, *Perichlamys*, for this fungus and attribute it to P. Hennings without explanation. This name does not appear to be justified.

A second collection of this unique species has recently become available for study from the Chicago Museum of Natural History. It was collected in 1922 by Macbride and Featherstone at Mito, Peru, on *Rhynchospora* (*Dichromena*) *macrochaeta*. Although the collection is scanty, there is sufficient material to demonstrate the gross characters as described by von Hoehnel and the spores

in particular are quite typical. Spores from the type collection, available for study through the courtesy of the Farlow Herbarium, are illustrated in figure 1 *B* and those from the Peruvian specimen

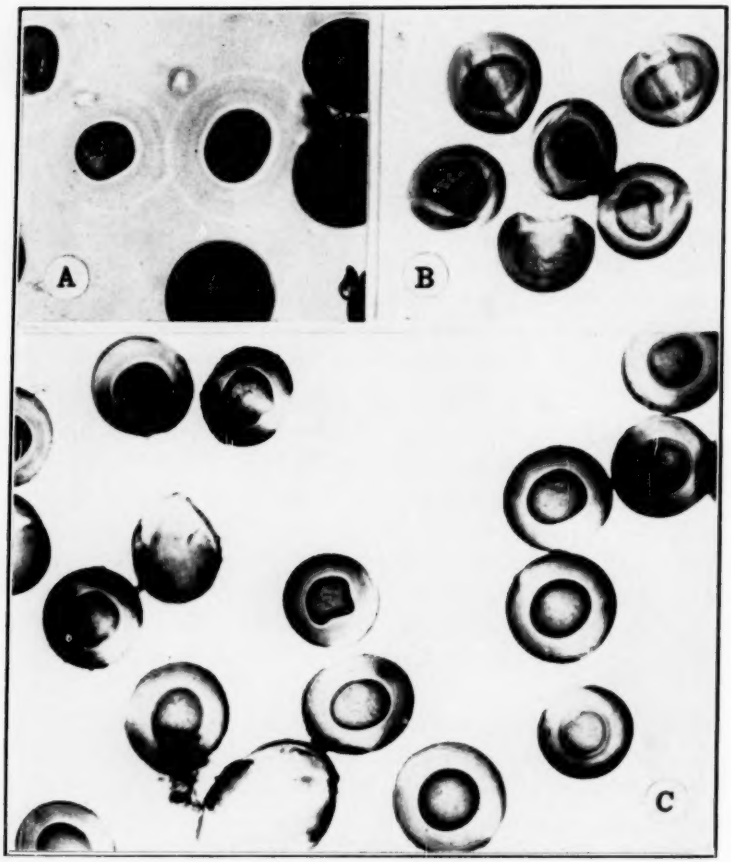

FIG. 1. *Cintractia ustilaginoidea*. *A*, spores from the Peruvian specimen, showing middle gelatinous layer; *B*, spores from the type collection; *C*, spores from the Peruvian specimen, showing outer and inner spore walls. All × 500. Photographs by A. G. Johnson.

in figure 1 *C*. The similarity of the two is striking. An attempt is made in figure 1 *A* to illustrate the gelatinous middle layer of spores from which the outer wall has broken away.

As pointed out by von Hoehnel practically the only difference between the fungus under discussion and certain species of *Cintractia,* such as *C. leucoderma* and *C. pachyderma,* lies in the possession of three layered spore membranes by the former. The outer membrane ruptures readily, permitting the spore proper with its gelatinous layer to pass out freely. Pressure of the cover slip in an ordinary mount breaks a considerable portion of the outer spore walls as seen in figure 1 *A*. As far as known this phenomenon does not take place in other species assigned to *Cintractia*. Von Hoehnel did not think these spore characters were of generic significance but the writers feel that they are and therefore prefer to maintain the fungus under the name *Kuntzeomyces ustilaginoideus* P. Henn.—LEE LING AND JOHN A. STEVENSON—(Food and Agricultural Organization of the United Nations, and Plant Industry Station, Beltsville, Md.).

ARTICLE 64 AND THE NOMENCLATURE OF LICHENS

It is perhaps the opinion of botanists generally who have given thought to Article 64 of the International Rules of Botanical Nomenclature that the primary intent of that Article is to eliminate as a *nomen confusum* any epithet based upon a type specimen containing parts of different species which had been assumed by the author of that epithet to be one species only, as in the case of a type consisting of flowers of one species, leaves of another, etc. In instances of this kind there is proper doubt as to which of the several species the epithet may apply. Since in the case of lichens every type specimen inevitably would contain a fungus and its algal symbiont, some interpretations of Article 64 would invalidate practically all lichen nomenclature—a result most certainly not contemplated by the authors of the Article and one that actually reduces the Rule to absurdity. Such legalistic hair-splitting is, however, the inevitable result of acceptance of the widely held doctrine that a lichen is a 'dual organism,' part fungus, part alga.

It is, of course, true that most elementary text-book definitions, and those in dictionaries also, continue to propagate the notion that a lichen is a combination of two components, a fungus and an alga, living in some sort of symbiotic relationship. This con-

cept of lichens as an ecological association would logically preclude their recognition as phylogenetic and taxonomic entities by the usual system of classification; and to accept it would require a new lichen nomenclature—an entirely needless and disorganizing performance. The lichens have received unusually competent monographic treatments with a well-recognized and accepted nomenclature; in fact in the entire history of systematic botany the nomenclature of lichens has been characterized by less confusion than that of other thallophytes. It is usually taken for granted nowadays that certain erroneous concepts of a former time can be corrected without invalidating all the previous pertinent nomenclature. Thus what is commonly called a 'lichen thallus' is recognized today as a peculiar colonial development of a fungus that is in close association, symbiotic or parasitic, with a colony of algal cells, of one or more species, which it encompasses. The morphological features most significant in the taxonomy of lichens are structures clearly recognized as fungal; and the fungus in many instances can be propagated in pure culture free from its algal associate. The characters and identities of the algal 'symbionts' or 'hosts' are of secondary taxonomic significance; in fact in some cases lichen species may have more than one species of algal associates. Even if some taxonomists of lichens have recognized that in certain genera all the species are limited to one genus of algal associates that fact is of no more taxonomic consequence than recognition of the fact that in certain genera of parasitic fungi all the species are restricted to related host plants. The significance of the alga on the morphology and taxonomy of the lichen is of no more moment than that of the symbionts, hosts or nutritive substrata of many other fungi. The fact, of late widely recognized, that species of *Septobasidium* derive their nutrition primarily from scale-insects rather than from the bark of trees to which they are attached, and that this relation is responsible in large part for their peculiar lichen-like aspect has caused no fear that the nomenclature of species of *Septobasidium* is invalid. Likewise recognition of the symbiotic relation of certain agarics and boletes to the roots of some higher plants can hardly be expected to have any revolutionary effect upon the nomenclature of either associate. If later investigations disclos-

ing new information on the nutritive relations of an organism necessarily invalidates its name then all nomenclature becomes an irrational nightmare.

The fact that original descriptions of lichens have included characters of the gonidia (cells of the algal associate), unfortunately often called the "algal component of the lichen," is small cause for invalidating their names. Recognition of the relation of gonidia adds no real confusion to lichen systematics. Most descriptions of plants as originally drawn later require emendation; and the fact that most descriptions of lichens assumed or stated that gonidia were an integral part of the named organism rather than symbionts or hosts, as is the modern concept, is fundamentally inconsequential, except for the assumption in some quarters that these earlier descriptions contravened Article 64 of the present-day Rules.

The modern concept of lichens with gonidia recognized as symbionts or hosts should preclude the invalidation of their names on account of the wording of Article 64; but, lest the present wording of that Article provide any impediment to the present well accepted nomenclature of lichens, in the minds of those who prefer to regard a lichen as a 'dual organism' it is here proposed that it be emended as follows:

Art. 64.—add sentence to read as follows:

"For purposes of nomenclature lichens are to be treated as fungi except as limited by Art. 20 (d)."

—WILLIAM W. DIEHL, U. S. Plant Industry Station,
Beltsville, Maryland.

SOME XYLARIAS FROM PANAMA[1]

For about sixteen months in 1944–45, the writer was on duty at the Army School of Malariology in the Panama Canal Zone. During that period there were only occasional opportunities for collecting plants. Among the fungi collected at that time were eight species in the genus *Xylaria* Hill. Determinations were made by Dr. Julian H. Miller and dried specimens were placed

[1] Contributions from the Botanical Laboratory, The University of Tennessee, N. Ser. No. 104.

in the herbarium of The University of Tennessee. It is believed that these collections should be recorded here.

Xylaria cubensis Mont. No. 16598, on decaying wood, near La Joya, Republic of Panama, July 18, 1944. Listed from Barro Colorado Island in the Canal Zone by Standley (Smith. Misc. Coll., **78**, No. 8, 1–32, 1927).

Xylaria rhizomorpha Mont. No. 16600, on decaying wood, near La Joya, Republic of Panama, July 18, 1944.

Xylaria scruposa Mont. No. 16604, on log, Barro Colorado Island, Canal Zone, July 21, 1944.

Xylaria comosa Mont. No. 16605, on decaying wood, Barro Colorado Island, Canal Zone, July 21, 1944. Reported by Weston (Sci. Monthly, **36**: 387–407, 1933) from Barro Colorado Island.

Xylaria grammica Mont. No. 16621, on log, near La Joya, Republic of Panama, Oct. 12, 1944. Reported by Weston (Sci. Monthly, **36**: 387–407, 1933) from Barro Colorado Island.

Xylaria guayanensis Mont. No. 16625, on log, near La Joya, Republic of Panama, Oct. 12, 1944.

Xylaria scopiformis Mont. No. 16626, on log, near La Joya, Republic of Panama, Oct. 12, 1944.

Xylaria multiplex (Kze. ex Fr.) B. & C. No. 16631, on log, Barro Colorado Island, Canal Zone, Nov. 5, 1944.—SAMUEL L. MEYER.

SCIENTISTS AND RESERVE OFFICERS

The Department of the Army has established a program of particular interest to mycologists and other scientists who hold Reserve commissions in the Army, and who are professionally engaged in teaching or research and development.

The objectives of the program are to:

(1) maintain the useful affiliation of mycologists and other scientists with the Organized Reserve Corps,
(2) provide peacetime Reserve assignments for these officers, enabling optimum utilization of their education, experience and skills,
(3) furnish mobilization assignments which will fully utilize their talents, and
(4) adequately prepare these officers for mobilization.

The Technical Services of the Department of the Army submit to these Research and Development Reserve Groups research problems and projects which pose an intellectual challenge to members of the groups. Thus, the program provides members of each group a type of training which is in keeping with their scientific and technical interests and competence, rather than a traditional kind of training session in which scientists have little or no interest.

The program is now being implemented only in those areas where there is a definite local interest. To date, eighteen Research and Development Reserve groups have been organized. Twelve additional groups are in process of organization. Others are in the initial stages of formation. Several of these groups have been formed in communities in which large universities, industrial research laboratories, or private research foundations are located. Typical localities are Chicago, Illinois; Wilmington, Delaware; Newark, New Jersey; Houston, Texas; Washington, D. C.; Manhattan and Lawrence, Kansas; Champaign-Urbana, Illinois; Pittsburgh, Pennsylvania; Denver, Colorado; and Detroit, Michigan.

Provision is made to submit research projects of interest to all categories of scientists—chemists, physicists, engineers, geologists, geographers, psychologists, mathematicians, and all of the biological scientists which will include mycologists.

Reserve officers who are currently engaged in civilian research, college or university teaching, or industrial research or development, or who in the past have had specific research experience are eligible to make application for assignment to an Organized Reserve Research and Development Group. A group may be organized in any locality where there are twenty (20) or more qualified officer scientists who desire to participate in the program. A subgroup may be organized with ten (10) qualified members.

The program is under the general direction of the Research and Development Group, Logistics Division, General Staff, United States Army. The entire program is outlined in the Department of the Army Circular Number 127, dated 5 May 1948.

Inquiry about organization of an Organized Reserve Research and Development Group or about assignment to a group already

organized should be made of the Unit Instructor, ORC, or of the Senior Army Instructor, ORC, in the locality in which the officer resides. In localities in which a group has already been organized, the Commanding Officer of the group will consider applications for assignment of additional officers.

PREVENTION OF DETERIORATION ABSTRACTS

The National Research Council of the National Academy of Sciences (Prevention of Deterioration Center, Room 204), 2101 Constitution Avenue, Washington, D. C., offers the 'Prevention of Deterioration Abstracts' on a yearly subscription basis. These Abstracts are classified under the following headings: Biological Agents; Electrical and Electronic Equipment; Fungicides and Other Toxic Compounds; Lacquers, Paints and Varnishes; Leather; Lubricants; Metals; Miscellaneous; Optical Instruments and Photographic Equipment; Packaging and Storage; Plastics, Resins, Rubbers, and Waxes; Textiles and Cordage; Wood and Paper. Cross references are included in each issue; author and subject indexes are compiled at the conclusion of each volume. Material for the Abstracts is obtained from journal articles, patents, and unpublished reports from government, university, and industrial research groups both here and abroad.

Approximately 2000 pages are published a year, in two volumes of six issues each. The individual abstracts are in loose leaf form so that they may be arranged in any manner desired by the individual receiving them. Comments are added to many of the abstracts to correlate relevant information, to evaluate reports, or to make suggestions for further research.

The yearly subscription rate, which includes two sturdy binders and index guides, is currently $37.50. The rate will be $50.00 for requests received after July 1, 1949. All subscriptions run from July 1st to June 30th. Back issues are available from April 1946 when the series was started.

An 'Advance List,' a monthly bibliography of all the reports received in this field by the Prevention of Deterioration Center is also available for an additional $10.00 per year.

BOOK REVIEWS

INTERNATIONAL RULES OF BOTANICAL NOMENCLATURE, compiled from various sources by W. H. Camp, H. W. Rickett, and C. A. Weatherby. Published in 1948 by Chronica Botanica Co., Waltham, Mass., and Stechert-Hafner, Inc., New York City. (Price $3.50.)

This publication was prepared by the Committee on Nomenclature of the American Society of Plant Taxonomists consisting of W. H. Camp, H. W. Rickett and C. A. Weatherby and was originally published in Brittonia (**6**: 1–120. 1947). The republication by Chronica Botanica has made the compilation generally available. The third edition of the International Rules of Botanical Nomenclature (1935) has been closely followed, with such modifications and additions as are required by the actions of the Congress at Amsterdam in 1935. One of the most important deviations from the third edition is the treatment of "Nomina Generica Conservanda." Generic names proposed for conservation have been included with officially adopted names in Appendix III. The genera of Phanerogamae are arranged according to Dalla Torre and Harms, *Gen. Siphonogam.* and the genera of other groups alphabetically. A grouping of names by families is also given for the Algae and Fungi. A general alphabetical index to all the names treated in Appendix III is added. This treatment is very useful but the inclusion of both adopted and proposed names may lead to some confusion.

It is stated in the preface that the publication is an unofficial compilation prepared to facilitate the study of nomenclatural questions. It is of special importance now when proposals for the next International Botanical Congress are under consideration.—E. B. MAINS.

BIOLOGY OF PATHOGENIC FUNGI, with foreword by J. G. Hopkins, M.D. Edited by Walter J. Nickerson. Pp. i–xx, 1–236. Waltham, Mass.: The Chronica Botanica Co.; New York City: Stechert-Hafner, Inc. (Price $5.00.)

This volume is the sixth in the series Annales Cryptogamici et Phytopathologici and is in the form of a symposium of articles by various investigators. A brief introduction by the editor is followed by four papers or chapters which summarize the information available on individual fungous disease groups, each written by a specialist in the group concerned. These include accounts of the pathogenic Torulopsidaceae by J. Lodder and A. de Minjer; Chromoblastomycosis, by A. L. Carrion and M. Silva; *Pityrosporum ovale* by R. W. Benham, and of *Coccidioides* by C. W. Emmons. These accounts bring to a focus a vast amount of scattered literature, and similar accounts of other fungus pathogens would be welcome. The use of the form genus name *Fonsecaea* for the pathogens of Chromoblastomycosis which have three types of conidial formation, each of which already bears a form genus name (*Phialophora, Hormodendron, Acrotheca*), raises the question as to whether we are now liable to be inflicted with new generic names for all combinations and permutations of the conidial stages of pleomorphic fungi. The recognition and establishment of some rules of usage for form genera names, in the International Code of Nomenclature, is a matter that should receive attention.

Cifferi and Raedelli outline the recent work done in Italy in Mycophthology, and D. S. Martin discusses the geographic distribution of systemic fungous diseases, with the aid of world maps for each disease group. The remaining chapters deal with the biology of the pathogenic fungi in general. They include discussions of the action of sulfonamides and antibiotics, by F. T. Wolf; the lipids of fungi, by R. L. Peck; Nutrition and Metabolism, by W. J. Nickerson and J. W. Williams. These chapters, again bring together and synthesize much scattered information concerning the physiology of these fungi.

This volume is of particular value to those interested in the pathogenic fungi because of the biological, rather than the clinical or taxonomic, approach found in most other books on this subject. This viewpoint results in the collection and analysis of the known information on the metabolism of these fungi, which will, of necessity, be fundamental to further studies and practical applications in this field.—L. E. WEHMEYER.

CORRECTIONS

In the description of *Helicogloea Sebacinoidea* Olive (Mycologia **40**: 588–590. 1948) the basidiospore measurements should read: 5.2–8.7 × 17.4–25.2 μ.—LINDSAY S. OLIVE.

The rust genus *Kernia* was described by the writer to accommodate a rust species on *Litsea* sp. in South India (Mycologia **38**: 679–686. 1946). In checking through the list of genera of fungi so far known, the writer found that the name *Kernia* had already been used by Nieuwland (Amer. Midl. Nat. **6**: 379–386. 1916) by transferring *Magnusia* Sacc. Neither Clements and Shear (The Genera of Fungi, 1931) nor Ainsworth and Bisby (A Dictionary of the Fungi, 1945) mention about *Kernia* Nieuwland. Since *Kernia* Nieuwland is already represented in literature, the writer proposes the name *Kernella* Thirum. for the rust on *Litsea* sp. with the type species *Kernella Lauricola* Thirum. nom. nov.—M. J. THIRUMALACHAR.

MANUSCRIPT

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